CO-OCCURRING ANXIETY IN ADULTS WITH AUTISM SPECTRUM DISORDER: USE OF DIAGNOSTIC CODES TO MEASURE PREVALENCE AND ASSOCIATIONS BETWEEN ANXIETY AND INTELLECTUAL ABILITY, ADAPTIVE BEHAVIOR, AND EMPLOYMENT

by

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ABSTRACT

Children with autism spectrum disorder (ASD), a neurodevelopmental disability, continue to be affected by the disorder in adulthood. Research shows that many adults with ASD have poor outcomes in adulthood, regardless of intellectual ability or severity of symptom impairment, when compared to typically developing adults or adults with other disabilities. The burden of psychiatric comorbidities may be one of these contributing factors.

Several studies have been conducted to evaluate the prevalence of psychiatric comorbidity in individuals with ASD. and anxiety disorders are among the most common co-occurring psychiatric diagnoses in adults with ASD. Anxiety disorders are found to impact life outcomes in typically developing adults and it is possible they are also limiting individuals with ASD. Co-occurring anxiety has been widely studied in children and adolescents with ASD, but there is limited research on the prevalence and types of anxiety in adults with ASD. The aim of this study is to describe co-occurring anxiety disorders in a large sample of adults with ASD identified through medical billing codes from electronic healthcare records and in-person assessments of psychiatric conditions. The data on several participants who overlap will be compared to evaluate the validity of using medical billing codes to evaluate health status of participants with ASD. Lastly, associations between co-occurring anxiety and factors of adaptive functioning will be drawn for the potential that co-occurring anxiety may impact one's ability to gain full

independence. Ideally this study will help close the knowledge gap and provide important information for improving the identification and treatment of co-occurring anxiety in adults with ASD.

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INTRODUCTION

Children with autism spectrum disorder (ASD), a neurodevelopmental disability, display deficits in social communication and interaction, repetitive behaviors, restricted interests, and frequently have accompanied intellectual disability, language impairment, or comorbid medical or psychiatric conditions (American Psychiatric Association, 2013). This disorder occurs within a spectrum of impairment with some individuals showing severe disability and others showing minimal symptoms (Baker, 2013). Typically diagnosed during childhood, ASD continues to affect individuals well into adulthood. Research shows that many adults with ASD have poor outcomes in adulthood, regardless of intellectual ability or severity of symptom impairment, when compared to typically developing adults or adults with other disabilities (Barneveld, Swaab, Fagel, van Engeland, & de Sonneville, 2014; Billstedt, Gillberg, & Gillberg, 2005; Eaves & Ho, 2008; Farley et al., 2009). The question still exists as to why these individuals are unable to live independently, maintain employment, and develop typical social relationships. Although symptoms of ASD, like rigidity or social communication deficits, can limit affected individuals, it is hypothesized that additional factors are contributing to difficulties in adulthood (Taylor & Mailick, 2014). The burden of psychiatric comorbidities may be one of these contributing factors (Buck et al., 2014).

Several studies have been conducted to evaluate the prevalence of psychiatric comorbidity in individuals with ASD (Buck et al., 2014; Cervantes & Matson, 2015;

Croen et al., 2015; Hallerback, & Gillberg, 2011; Hofvander et al., 2009; Joshi et al., 2013; Kanne, Christ, & Reiersen, 2009; Lugnegard,). Anxiety, depression, and attention deficit hyperactivity disorder are among the common comorbid disorders diagnosed in individuals with ASD (Buck et al., 2014; Cervantes & Matson, 2015; Croen et al., 2015; Hofvander et al., 2009). Anxiety is among the most common co-occurring psychiatric diagnoses in adults with ASD (Buck et al., 2014) and has been found to impact life outcomes in typically developing adults (Barrera & Norton, 2009). Co-occurring anxiety has been widely studied in children and adolescents with ASD, but there is limited research on the prevalence and types of anxiety in adults with ASD. Without a clear understanding of the comorbid disorders seen in adults with ASD, it is challenging to develop and evaluate treatments to help these individuals obtain their maximum potential (Buck et al., 2014). The aim of this study is to describe co-occurring anxiety disorders in a large sample of adults with ASD identified through medical billing codes from electronic healthcare records and in-person assessments of psychiatric conditions. The data on several participants who overlap will be compared to evaluate the validity of using medical billing codes to evaluate health status of participants with ASD. Lastly, associations between co-occurring anxiety and factors of adaptive functioning will be examined to determine if co-occurring anxiety impacts one's ability to gain full independence. Ideally, this study will help close the knowledge gap and provide important information for improving the identification and treatment of co-occurring anxiety in adults with ASD.

Characteristics of Autism Spectrum Disorder

The most recent report from the Center for Disease Control's (CDC) Autism and Developmental Disabilities Monitoring Network (ADDM) estimated that 1 in 68 children are identified with autism spectrum disorder (ASD; Miller et al., 2013). The current definition of ASD is far from what Leo Kanner first established in 1943 when he described 10 children to have "extreme autistic aloneness," as well as echolalia, preference for sameness, and repetitive behaviors. This description was coined "early infantile autism" (Kanner, 1943). In 1944, Hans Asperger identified a similar disorder, "Asperger's," as he described children presenting as "little professors" who lacked skills in social interactions but did not appear to have the same extreme behavioral difficulties as the children described by Kanner. This description would later be recognized as Asperger's syndrome (Wing, 1981).

In 1980, the American Psychological Association published the Diagnostic and Statistical Manual of Mental Disorders, Third Edition (American Psychiatric Association, 1980). This was the first DSM to recognize autism as a formal disorder (Baker, 2013). Labeled as infantile autism, it was said to be distinctively different from schizophrenia, displayed prior to the age of 2 ½ years, and marked by symptom criteria in three domains: reduced social responsiveness, impaired communication skills, and odd environmental responses (American Psychiatric Association, 1980; Baker, 2013). The criteria for autism changed again in 1987 with the DSM-III revision (DSM-III-R), as did the name, which was changed to autistic disorder (American Psychiatric Association, 1987; Baker, 2013). The criteria for autistic disorder required individuals to meet 8 of the 16 criteria in the three different domains and included a new category for children who

met some but not all of the diagnostic criteria. This category was called pervasive developmental disorder, not otherwise specified (PDD-NOS). The DSM-III-R also removed the requirement that symptoms must be present prior to the age of 3 years (American Psychiatric Association, 1987; Baker, 2013). The DSM-IV further revised the criteria for pervasive developmental disorder to include autistic disorder, PDD-NOS, Asperger's disorder, and Rett's syndrome (American Psychiatric Association, 1994). These revisions are important to our understanding of ASD because they provide further evidence that, as clinicians and researchers, we have been struggling to define autism since the 1980s. The various revisions have had an impact on individuals with the diagnosis and the process of researching the disorder (Baker, 2013; Cottle, McMahon, & Farley, 2016).

In the DSM-5, autism is currently referred to as autism spectrum disorder under the category of neurodevelopmental disorders and defined by two diagnostics categories: deficits in social communication and social interaction; restricted, repetitive patterns of behavior, interests, or activities. While impairment must be present in early development, it might not become apparent until social demands increase with age (American Psychiatric Association, 2013). The DSM-5 no longer includes the diagnoses Asperger's syndrome or PDD-NOS and requires clinicians to specify the level of support required by the individuals and whether or not the diagnosis is accompanied by an additional language impairment or intellectual disability. Finally, the DSM-5 revisions removed the stipulation that attention deficit hyperactivity disorder (ADHD) and obsessive compulsive disorder could not be diagnosed along with a pervasive developmental disorder (American Psychiatric Association, 2013).

ASD prevalence is significantly higher in males than females. While ASD's underlying etiology is currently unknown, several environmental factors and genetics findings are associated with increased risk for developing ASD (Bailey et al., 1995; Bakian, Bilder, Coon, & McMahon, 2015; Bilder, Pinborough-Zimmerman, Miller, & McMahon, 2009; Muhle, Trentacoste, & Rapin, 2004). There are no known cures for ASD but behaviorally-based interventions, such as those based on applied behavior analysis and pivotal response training, have been determined effective in reducing symptom severity (American Psychiatric Association, 2013; Rogers & Vismara, 2008). There is no specific medication to reduce core features of ASD, but co-occurring conditions are frequently targeted with psychotropic medications (Buck et al., 2014).

The measured prevalence of ASD has been increasing over the last few decades (Centers for Disease Control, 2014). While environmental factors may be influencing this trend, other factors such as case definition, increased awareness, and improved diagnostic assessment tools may also contribute to this phenomenon (Miller et al., 2013).

Outcomes in Adulthood

Until relatively recently, autism was characterized by its early onset in childhood and conceptualized as a childhood disorder. As more children were identified with ASD, early diagnosis and treatment quickly became the focus of research (Baker, 2013; Cottle, McMahon, & Farley, 2016). ASD studies that included adults were few and often had small sample sizes relative to the research focused on children at-risk for or diagnosed with ASD (Cottle, McMahon, & Farley, 2016). ASD in adulthood is now emerging as a significant focus of research (Bilstedt, 2005; Cottle, McMahon, & Farley, 2016; Farley et

al., 2009; Roux, Shattuck, Rast, Rava, & Anderson, 2015). Research on adult outcomes is typically reported across several different domains: cognitive ability, independence, social relationships, education and employment, and symptom impairment or behavior and comorbid conditions (Eaves & Ho, 2008; Farley et al., 2009; Roux, 2014). These studies remain largely descriptive but some compare adults with ASD to adults with other disabilities or typically developing adults (Barneveld et al., 2014). Rating systems have been established to reflect overall functioning achieved by adults with ASD (Billstedt, Gillberg, & Gillberg, 2005; Eaves & Ho, 2008; Engstrom, Ekstrom, & Emilsson, 2003; Farley et al., 2009). The following describes the existing literature by specific domains and overall functioning.

Cognitive Ability

The most common reporting of cognitive abilities in adults with ASD has been change in abilities across longitudinal or follow-up studies. Magiati, Tay, and Howlin (2014) reviewed the literature on cognitive functioning in adulthood. While the majority of studies included in the review reported that cognitive abilities of individuals with ASD remain stable over time, individual scores show large amounts of variability, with some individuals showing either increases or decreases greater than one standard deviation (Farley et al., 2009; Sigman & McGovern, 2005). More specifically, Sigman and McGovern (2005) reported that some individuals displayed declines in IQ score over time. Howlin, Goode, Hutton, and Rutter (2004) and Mawhood, Howlin, and Rutter (2000) both reported significant increases in cognitive ability, specifically verbal IQ, in a small percentage of participants. Gains in cognitive ability were typically associated with

better adult outcomes (Farley et al., 2009) and individuals with more significant autism symptomatology were found to have lower cognitive abilities, which remained stable or decreased over time (Cederlund, Hagberg, Billstedt, Gillberg, & Gillberg, 2008).

Independence

Research is showing that a large majority of adults with autism fail to achieve full independence in adulthood, with many requiring familial or social support (Farley et al., 2009). In 2014, Buescher, Cidav, Knapp, and Mandell reported that the lifetime cost of supporting an individual with an intellectual disability and ASD was $2.4 million dollars. To support an individual without an intellectual disability and ASD was $1.4 million dollars. Residential care or support during adulthood and loss of individual productivity were noted as significant contributors to overall cost (Buescher et al., 2014). Adults with ASD typically require a high level of assistance (Engstrom, Ekstrom, & Emilsson, 2003; Farley et al., 2009). Some adults live independently, but a large majority live with parents, family members, or within group homes (Eaves & Ho, 2008; Engstrom, Ekstrom, & Emilsson, 2003; Farley et al., 2009). A large majority of adults who live independently receive a large amount of support from local family members (Farley et al., 2009). In addition to relying on familial support, many adults with ASD receive support from public funding sources, such as vocational rehabilitation, supplemental security income, or Medicaid (Engstrom, Ekstrom, & Emilsson, 2003; Farley et al., 2009).

Social Relationships

Social relationships are an innate factor of adult life, but studies show that adults with ASD fail to participate in typical social relationships in adulthood. Adults with ASD without intellectual disability rarely engage in romantic relationships (Engstrom, Ekstrom, & Emilsson, 2003; Farley et al., 2009). In a follow-up study of more cognitively able adults, 44% of adults had never dated and only 19% of adults had engaged in long-term romantic relationships, including marriage (Farley et al., 2009). Eaves and Ho (2008) found that 33% of adults with ASD were active in friendships and friendly social activities. Farley et al. (2009) reported similar findings and suggested that a large majority of adults participated in social or organized activities, such as church activities or Special Olympics sports (Farley et al., 2009). Given that ASD is marked by social communication and interaction deficits, some of these findings might not be surprising; but, like employment, some studies show lower rates of social relationships and activities when adults with ASD are compared to adults with other disabilities. When compared to adults with ID, emotional disturbance, or learning disorders, adults with ASD were more likely to be social isolated and show irregular social functioning (Orsmond, Shattuck, Cooper, Sterzing, & Anderson, 2013), adding to the evidence that adults with ASD show impairments in their social relationships.

Symptom Impairment, Behavior, and Comorbid Conditions

Self-injurious behavior (SIB), social difficulties, and disruptive behavior are all common symptoms studied in childhood. Several researchers investigated whether or not these difficulties were still present in adulthood. Kats, Payne, Parlier, and Piven (2013)

investigated specifically older adults with ASD and ID when compared to older adults with just ID. As adults age into later adulthood, it is unknown as to what difficulties they will encounter and what support will be needed (Cottle, McMahon, & Farley, 2016; Wright, Brooks, D'Astous, & Grandin, 2013). Kats et al. (2013) found that 40-60% of adults with ASD and ID required support to manage SIB and disruptive behavior. It was reported that SIB and disruptive behaviors doubled in adults with ASD and ID when compared to adults with ID alone (Kats et al., 2013). While many studies report similar symptom impairment or lessened symptom severity in adulthood (Farley et al., 2009), several studies have noted a phenomenon where individuals with ASD show a decrease in symptom severity in later adolescence but then experience an increase in symptom severity in early adulthood (Vannucchi et al., 2014; Wei, Wagner, Hudson, Yu, & Shattuck, 2015). Vannucchi and colleagues (2014) referred to this concept as the setback phenomenon, where individuals show an increase in social difficulties, preference for sameness, and strict limitation for interests. The authors hypothesized that comorbid psychiatric conditions could be worsening at this time, increasing the impact of the setback (Vannucchi et al., 2014). Many studies have reported comorbid medical and psychiatric conditions (Buck et al., 2014; Howlin, 2000; Jones et al., 2015). More common comorbid medical conditions in adults with ASD were found to be constipation, obesity, insomnia, and seizures (Jones et al., 2015). Several studies have also reported common co-occurring psychiatric disorders, such as depression, anxiety, and ADHD (Buck et al., 2014; Howlin, 2000). Given the impact of the co-occurring psychiatric conditions and their relevance to this project, these co-occurring disorders will be discussed in further detail in a later section.

Education and Employment

Studies on outcomes in adulthood consistently report that less than half of adults with ASD are currently or ever have been employed (Eaves and Ho, 2008; Farley et al., 2009; Howlin, 2000). In addition, a large majority of adults with ASD have lost jobs, are employed in relatively low-level positions, and require on-the-job supports (Eaves & Ho, 2008; Farley et al., 2009; Howlin, 2000). One striking factor is that not only are adults with ASD relatively underemployed compared to typically developing adults but also when compared to adults with other disabilities (Barneveld et al., 2014; Roux et al., 2013). These findings occur among adults with ASD with and without intellectual disability (Baldwin, Costly, & Warren, 2014; Farley et al., 2009). Baldwin et al. (2014) investigated the work experiences of adults with Asperger's syndrome or High Functioning ASD diagnoses. They found that almost half of the adults were overeducated for their job and more than half of the adults required some support in their employment setting (Baldwin et al., 2014).

Along with being underemployed, adults with ASD are not enrolling in postsecondary education or completing advanced degrees (Baldwin et al., 2014; Farley et al., 2009; Roux et al., 2013; Wei et al., 2015). Farley et al. (2009) reported that 39% of the more cognitively able participants in their sample went on to receive postsecondary education. Wei et al. (2015) investigated education and employment attainments of adults 2, 4, and 6 years after high school graduation. Two years after high school, most of the young adults were not enrolled in postsecondary education and were unemployed. The unemployment rates dropped 4 years after high school but then increased again 6 years after graduation. Overall, 29% of participants were reported to be continuously or

increasingly disengaged from education or employment after high school graduation (Wei et al., 2015). Despite many adults with ASD being cognitively able, achieving higher education, and obtaining some employment opportunities, rates of employment in adults with ASD rarely increase above 50% (Baldwin et al., 2014; Henninger &Taylor, 2013; Roux et al., 2013; Vogeley, Kirchner, Gawronski, van Elst, & Dziobk, 2013; Wei et al., 2015). As of today, very few high-quality vocational interventions exist and most lack strong methodology or do not yield consistently positive results (Taylor et al., 2012). Vogeley et al. (2013) suggested that the assessment tools used prior to an intervention need improvement and interventions might be more effective if individual's preference were better matched with the requirements of the work place. There is currently a high need to investigate the employment difficulties and potential barriers to employment experienced by adults with ASD to develop interventions that improve outcomes of adults with ASD (Barneveld, Taylor, Henninger, Mailick; 2015; Roux et al., 2013; Vogeley et al., 2013; Wei et al., 2015).

Overall, the literature base thus far shows that rates of employment in adults with ASD tend to be lower than when compared to typically developing peers and adults with other developmental disabilities. Several studies have shown that even adults with average or above average IQ are unable obtain gainful employment (Farley et al., 2009; Wei et al., 2015). Adults with ASD are shown to have difficulty obtaining and maintaining employment, but this is also true for adults with other psychiatric conditions. Mojtabai et al. (2015b) reported that adults with lifetime disorders had reduced odds of being employed than their counterparts. Employment or student status at initial evaluation predicted employment at the follow-up assessment, but lifetime history of

anxiety was found to impact one's employment abilities (Mojtabai et al., 2015b). In a study of employment status among veterans, researchers found that participants with depression or anxiety were less likely to be employed. They participants reported more employment barriers and had reduced levels of work performance (Zivin et al., 2016). A Norwegian study of health and unemployment was interested in this same concept, as much of the current literature discusses how unemployment influences health. Researchers found that participants with anxiety were at increased risk of unemployment (Kaspersen et al., 2016). Given that typically developing adults with anxiety experience difficulty maintaining employment, it is likely that co-occurring anxiety also negatively impacts adults with ASD, a population of individuals who appear to have high rates of co-occurring anxiety.

Overall Outcomes

In an attempt to quantify outcomes in adulthood, many researchers created and use outcome ratings to represent overall outcomes in adults with ASD. These ratings were based on social relationships, education or employment, and independent living (Eaves & Ho, 2008; Farley et al., 2009). Eaves and Ho (2008) reported that 21% of adults obtained an overall outcome rating (OOR) of good or very good. None of the adults received a poor rating and it was noted that emotional difficulty was very common in the participants (Eaves & Ho, 2008). Another study reported poor ratings in 78% of participants and stated that childhood IQ and phrase speech were positively correlated with better adult outcome (Billstedt, Gillberg, & Gillberg, 2005). Lastly, Farley et al. (2009) reported better overall outcomes, with 48% of participants obtaining very good or

good ratings. Farley et al. (2009) commented on the high level of social and religious support provided to the individuals in the community, a factor that may improve these ratings (Farley et al., 2009). While these rating systems are beneficial, they have large measurement errors, are not standardized, and do not incorporate the individual's perspective (Henninger & Taylor, 2013). Barneveld et al. (2014) measured Quality of Life (QoL) in adults with ASD and compared these scores with those of adults with attention deficit hyperactivity disorder, disruptive behavior disorders, and affective disorders. QoL was worse in adults with ASD. These adults had lower levels of education and fewer paid employment positions; a large proportion received supplemental security income. Although many individuals with ASD in this study were highly educated, they still reported lower QoL (Barneveld et al., 2014). Some studies report relatively positive outcomes in adults with ASD (Farley et al., 2009), but the large majority of studies suggest that adults with ASD are not reaching their full potential and it is unknown as to why (Eaves & Ho, 2008; Wei et al, 2015).

Comorbid Psychiatric Conditions

Through our recently improved understanding of ASD symptoms and diagnostic tools, it has come to the attention of researchers and clinicians that individuals with ASD frequently suffer from co-occurring psychiatric disorders (Buck et al., 2014; de Bruin, Ferdinand, Meester, de Nijs, & Verheij, 2007; Howlin, 2000; Roy, Prox-Vagedes, Ohlmeier, & Dillo, 2015). Estimates of at least one co-occurring condition in individuals with ASD range from 5-80% (de Bruin at al., 2007). The most common co-occurring psychiatric conditions are reported to be mood disorders, ADHD, and anxiety (Bjorn et

al., 2009; Buck et al., 2014; de Bruin et al., 2007; Lungeard et al., 2011). While co-occurring psychiatric conditions are observed in individuals of all ages, the focus of this project is on co-occurring conditions in adults. The literature shows similar findings between children and adults in regards to depression, anxiety, and obsessive-compulsive disorder (Bakken et al., 2010; Buck et al., 2014; Croen et al., 2015; Hofvander et al., 2009). Although ASD can greatly impact the outcomes of an adult with ASD, comorbid conditions could worsen symptoms of ASD, making optimum outcomes difficult for individuals to achieve (Vannuchi et al., 2013).

Anxiety

Anxiety disorders are said to be the most common co-occurring disorders in individuals with ASD. Prevalence reports of co-occurring psychiatric conditions vary across studies, but all concur that anxiety disorders frequently co-occur in individuals with ASD (Bakken et al., 2010; Buck et al., 2014; Croen et al., 2015; Hofvander et al., 2009; Roy et al., 2015).

Anxiety disorders are one of the most common disorders diagnosed in the general population with a lifetime prevalence of 28.8% (Bandelow, Lichte, Rudolf, Wiltink, & Beutel, 2014; Kessler et al., 2012; Kessler, Chiu, Demier, Merikangas, & Walters, 2005). Commonly developed in childhood, the different anxiety disorders (Table 1) are differentiated by a different fear or worry.

To meet criteria for a clinical anxiety disorder diagnosis, individuals must present with symptoms of excessive and persistent worry or fear that is determined to be out of proportion for the situation. These disorders are typically stress induced marked by

Table 1

Anxiety Disorders Defined

Disorder	Diagnostic features
separation anxiety disorder	Fear or anxiety of separating from attachment figures or home
selective mutism	Failure to initiate speech or reciprocally respond when spoken to in social situations
specific phobia	Fear in the presence of a specific object or situation
social anxiety disorder	Fear of social situations in which the individual is feared of being judged
panic disorder	Panic attacks that are unexpected and recurrent
panic attack specifier	Four or more physical symptoms occur in an abrupt surge of fear or discomfort, lasting several minutes
agoraphobia	Fear triggered by being exposed to or anticipating: using public transportation, being in open spaces, being in enclosed spaces, standing in line, being out of the home
generalized anxiety disorder	Excessive worry about numerous events or activities
substance/medication-induced anxiety disorder	Panic or fear due to the effects of a substance
anxiety disorder due to another medical condition	Anxiety best explained by effect of another medical condition
other specified anxiety disorder	Symptoms are characteristic of an anxiety disorder but does not meet full criteria and the clinician chooses to specify why the criteria is not met
unspecified anxiety disorder	Symptoms are characteristic of an anxiety disorder but does not meet full criteria and the clinician chooses not to specify why the criteria

Note: Definitions adapted from American Psychiatric Association, 2013

physical or psychological symptoms. Physical symptoms of anxiety include stomach aches, palpitations, sweating, shakiness, restlessness, and muscle tension. Psychological symptoms include feelings of danger, constant tension, worry, sleep disturbance, irritability, or cognitive ideation (American Psychiatric Association, 2013; Ghaziuddin, 2008). The National Comorbidity Survey Replication reported that 18.1% of adults surveyed presented with any anxiety disorder. The most commonly diagnosed anxiety disorders were specific phobia (8.7%), social phobia (6.8%), posttraumatic stress disorder (3.5%), generalized anxiety disorder 2.1%), and panic disorder (2.7%) (Kessler et al., 2012). A follow-up study on the lifetime prevalence of anxiety disorders in individuals aged 18 to 64 showed the following prevalence rates: specific phobia (13.8%), social phobia (13.0%), posttraumatic stress disorder (8.0%), generalized anxiety disorder (6.2%), and panic disorder (5.2%). The overall prevalence rate for any lifetime anxiety disorder was 33.7% (Kessler et al., 2012).

Anxiety is diagnosed using various rating scales and based on criteria described in the DSM-5 or the International Classification of Diseases, Tenth Revision (ICD-10; Bandelow et al., 2014). There is a large amount of research on anxiety disorders, in areas of both diagnosis and treatment. Individuals with acute and persisting anxiety frequently experience life impairments (Kessler et al., 2012), as well as lower quality of life than adults without anxiety (Barrerra et al., 2009).

Co-occurring Anxiety in Children With ASD

The majority of the available research on co-occurring anxiety in individuals with ASD has been conducted with children. Pediatric research on co-occurring anxiety

provides a context in which to study anxiety in adults with ASD. The research thus far has focused on describing the nature of anxiety in children with ASD, particularly how co-occurring anxiety disorders manifest in children (Hallett, Lecavelier, Sukhodolsky, & Cipriano, 2013; Kerns et al., 2014: Kerns & Kendall, 2013; Renno & Wood, 2013; Ung, Selles, Small, & Storch, 2014). Given the overlap of symptoms between anxiety and ASD, the goal of many research studies has been to determine whether common anxiety disorders seen in individuals with ASD exist independently or if they are simply manifestations of symptoms of ASD (Kerns & Kendall, 2013; Rodgers, Glod, Connolly, & McConachie, 2012). In addition to confirming that anxiety is a separate, co-occurring disorder, researchers are investigating whether or not the manifestation of anxiety in individuals with ASD is atypical or similar to that of children without ASD (Kerns & Kendall, 2013; Ozsivadjian, Hibberd, & Hollocks, 2014; Renno & Wood, 2013).

Several studies reported that higher levels of anxiety were found in children without comorbid intellectual disability, functional language abilities, and overall higher verbal comprehension index scores (Dubin, Lierberman-Betz, & Lease, 2015; Gotham, Brunwasser, & Lord, 2015; Hallett et al., 2013; Kerns et al., 2015; Kerns et al., 2014; Ung et al., 2014). Co-occurring anxiety was found in 41.7% of a sample of children identified to have high functioning ASD and higher cognitive abilities (Ung et al., 2014). When compared to children and adolescents without ASD, children with ASD displayed a higher prevalence of anxiety regardless of measure (Bitsika & Sharpley, 2015). Since co-occurring anxiety in youth was found to be more prevalent in children with functional language abilities and without accompanying intellectual disability, some suggest that the presence of anxiety is associated with lesser ASD severity (Hallett et al., 2013; Kerns et

al., 2015). However, children with co-occurring anxiety disorders were also more likely to display self-injurious behaviors and symptoms of depression (Kerns et al., 2015). Greater feelings of loneliness are associated with higher levels of self-reported anxiety (White & Roberson-Nay, 2009). Lastly, anxiety severity has been associated with greater functional impairment in children with ASD, suggesting that children with ASD and greater levels of anxiety experience worsened impairment that requires additional intervention (Ung et al., 2014).

The majority of screening or assessment tools for psychiatric conditions have only been validated in typically developing children, making it difficult to diagnose anxiety in children with ASD. Because of this, several researchers have evaluated the reliability of assessment tools used with children with ASD. Wigham and McConachie (2014) systematically reviewed the properties of tools used to measure co-occurring anxiety. The Spence Children's Anxiety Scale, Revised, Revised Children's Anxiety and Depression Scale, and the Screen for Child Anxiety Related Emotional Disorders were found to have good psychometric properties in children with ASD (Wigham & McConachie, 2014). Many studies have used parent reports or clinical parent interviews to measure anxiety in children with ASD. Ozsivadjian, Knott, and Magiati (2012) compared self-report measures of anxiety to parent-reported symptoms with the hopes of determining appropriate measures to demonstrate treatment outcomes. Kaat and Lucavelier (2015) also tested the validity and reliability between parent and child versions of the Revised Child Anxiety and Depression Scale and Multi-Dimensional Anxiety Scale. Both studies demonstrated good agreement between children with ASD and their parents on measures of anxiety, demonstrating the usability of these measures for prevalence or treatment

studies (Kaat & Lucavelier, 2015; Ozsivadjian, Hibberd, & Hollocks, 2014).

Self and caregiver reports of anxiety have proven to be reliable and valid for assessing anxiety in children with ASD, but it is unknown as to whether or not these children experience the physiological symptoms of anxiety in a similar manner as children without ASD. Lanni, Schupp, Simon, and Corbett (2012) evaluated physiological stress and reported experiences of anxiety in children with and without ASD. Interestingly, the children with and without ASD reported similar levels of anxiety throughout the experiment, but the children with ASD showed stable levels of cortisol, unlike their peers who displayed an increase (Lanni et al., 2012). Sharpley, Bitsika, Agnew, and Andronics (2015) also found that cortisol levels and reports of anxiety among children with ASD were consistent across time points; however, the cortisol levels and levels of reported anxiety were inconsistent (Sharpley et al., 2015). In addition to reduced cortisol levels, Hollocks, Howlin, Papadopoulos, Khondoker, and Simonoff (2014) found reduced heart rates in response to psychosocial stress in children with increased levels of anxiety. All of these studies suggest that stress responses in children with ASD are more complicated than typically developing children and the stress mechanisms in children with ASD could be contributing to higher levels of anxiety (Hollocks et al., 2014; Lanni et al., 2012; Sharpley et al., 2015).

Finally, the high prevalence of anxiety seen in children with ASD and associated difficulties has inspired a great deal of treatment research with the hopes of reducing symptoms of ASD. Wood et al. (2015) have conducted several studies evaluating the efficacy of cognitive behavioral therapy to reduce symptoms of anxiety in children and early adolescents. The majority of these studies found cognitive behavioral therapy to be

efficacious. The most recent study by Wood et al. (2015) demonstrated efficacy of cognitive behavioral therapy in a randomized control trial. Seventy-nine percent of the treatment group displayed clinical improvements compared to 28.6% of the waitlist group. Although improvements were seen based on a global improvement scale and parent-reported symptoms, self-report measures did not yield significant changes between groups (Wood et al., 2015). Kreslins, Robertson, and Melville (2015) reviewed the effectiveness of psychosocial interventions for children with ASD and co-occurring anxiety. The majority of studies demonstrated greater efficacy of psychosocial interventions when compared to treatment-as-usual or waitlist controls. Although the majority of measures in these studies showed decreases in anxiety, self-reported outcomes measures were less likely to show significant changes in posttreatment symptoms (Kreslins, Robertson, & Melville, 2015). The current availability of literature demonstrates the efficacy of psychosocial treatments for children with ASD when compared to waitlist or treatment-as-usual groups, but the literature also states the need for replication studies, use of larger sample sizes, and comparison to other treatments (Kreslins, Robertson, & Melville, 2015; Wood et al., 2015).

Anxiety in Adults With ASD

The available literature on co-occurring anxiety in children with ASD is rapidly increasing and providing avenues in which we can direct research on adults; however, there is still relatively little research on adults with ASD and co-occurring anxiety. Early studies reported a high prevalence of co-occurring anxiety in adults with ASD (Rumsey, Rapoport, & Sceery, 1985; Szatmari, Bartolucci, & Brenner, 1989; Tantam, 1991; Wing,

1981); but, surprisingly, after these studies in the 1980s and early 1990s, the reports of co-occurring psychiatric disorders were almost nonexistent. The most recent prevalence studies suggest that anxiety disorders are the most common co-occurring disorders in adults with ASD (Bakken et al., 2010; Buck et al., 2014; Croen et al., 2015; Hofvander et al., 2009; Roy et al., 2015). Some researchers have focused on the area of co-occurring social anxiety in adults with ASD (Maddox & White, 2015; Swain et al., 2015) and others have compared anxiety in individuals with ASD to that in individuals with intellectual disability (Bakken et al., 2010; Gillot & Standen, 2007) or typically developing adults (Hare et al., 2015). Today, the majority of the adult literature presents on prevalence (Bakken et al., 2010; Buck et al., 2014; Croen et al., 2015; Hofvander et al., 2009; Roy et al., 2015), and shows a large amount of variation in the type of study and reporting of these diagnoses.

Maddox and White (2015) and Lugnegard, Hallerback, and Gillberg (2011) both reported that social anxiety disorder was the most common anxiety disorder diagnosis in adults with ASD (Lugnegard, Hallerback, & Gillberg, 2011; Maddox & White, 2015). In the most recent study of co-occurring social anxiety in adults with ASD, Maddox and White (2015) examined the prevalence and clinical presentation of social anxiety disorder compared to adults without ASD. They found that a large proportion of adults with ASD also met criteria for social anxiety disorder and that the presentation of social anxiety disorder in these individuals was different from that of adults with social anxiety disorder without ASD (Maddox & White, 2015). These authors, along with Swain, Scarpa, White, and Laugeson (2015), raised in their discussion the impact of decreased emotional regulation and hypersensitivity to negative social interactions. Swain et al. (2015) found

that increased social anxiety was linked to difficulties with emotion regulation. Maddox and White (2015) also discussed the complexity of social anxiety, particularly the interaction between social deficits and the reduced ability to process negative social situations. It was suggested that adults with ASD are potentially more aware of their social deficits and have more negative social interactions; however, they lack the ability to regulate their emotions during or after social situations (Maddox & White, 2015; Swain et al., 2015). Both emphasized the need for additional research in the area of social anxiety in adults with ASD to improve diagnosis and subsequent treatment (Maddox & White, 2015; Swain et al., 2015).

In addition to reporting on overall prevalence in samples of adults with ASD, several studies have compared co-occurring anxiety in adults with ASD to anxiety in individuals with intellectual disability (Bakken et al., 2010; Gillot & Standen, 2007). Bakken et al. (2010) investigated psychiatric disorders in adolescents and adults with ASD and adults with intellectual disability. Using a checklist modified for individuals with autism, they found that the largest group differences were in the prevalence of co-occurring anxiety, with adults with ASD presenting with higher rates of anxiety (Bakken et al., 2010). Gillot and Standen (2007) used a modified version of the Spence Children's Anxiety Scale, Parent to compare anxiety disorders in adults with ASD and intellectual disabilities to adults with intellectual disabilities without ASD. The Spence provided subscales of panic attack and agoraphobia, separation anxiety, physical injury fears, social phobia, obsessive-compulsive disorder, and generalized anxiety disorder. A measure of stress was also administered to both groups. The adults with ASD in this study displayed higher rates of co-occurring anxiety, with panic and agoraphobia,

separation anxiety, obsessive-compulsive disorder, and generalized anxiety disorder being the most common. The group with autism also displayed more stress, especially with change and anticipation (Gillot & Standen, 2007). Individuals with intellectual disability commonly have difficulty completing standardized rating forms, so both studies utilized caregiver measures. However, both studies also emphasized the need to obtain self-reports of anxiety (Bakken et al., 2010; Gillot & Standen, 2007).

A large variety of study methodologies and measurement tools have recently been used to describe anxiety in adults with ASD. Some studies report current symptom presentation (Lugnegard, Hallerback, & Gillberg, 2011) and others present lifetime comorbidity of these diagnoses (Buck et al., 2014; Hofvander et al., 2009). Lugnegard, Hallerback, and Gillberg (2011) reported that 50% of the sample presented with co-occurring anxiety disorders and Hofvander et al. (2009) reported that mood and anxiety disorders were the most common in their study of adults with normal cognitive ability. Mazefsky, Folstein, and Lainhart (2008) investigated prevalence of mood disorders in 34 adults with ASD and their families. Almost 90% of that sample was identified as having at least one mood or anxiety diagnosis as measured by The Schedule of Affective Disorders and Schizophrenia – Lifetime Version. Phobias and generalized anxiety disorders were the most common, affecting 59% and 41% of the sample, respectively (Mazefsky, Folstein, & Lainhart, 2008). Overall, anxiety disorder prevalence rates among adults with ASD vary significantly across studies and few large-scale studies have been conducted.

In addition to varying prevalence rates, various tools have been used to measure comorbid psychiatric conditions, such as the Structured Clinical Interview for DSM-IV

Axis I Disorders (Lugnegard, Hallerback, & Gillberg, 2011), the Mini Psychiatric Assessment Schedules for Adults with Developmental Disabilities (Mini PAS-ADD; Buck et al., 2014), Hospital Anxiety and Depression Scale (Hare et al., 2015), Anxiety Disorders Interview Schedule for DSM-IV: Social Phobia Module (Maddox & White, 2015), parental or caregiver report of historical lifetime diagnoses (Buck et al., 2014; Hofvander et al., 2009), and medical billing codes from electronic healthcare records (Croen et al., 2015). Overall, these studies report the findings that anxiety appears to be co-occurring as a separate diagnosis in adults with ASD, but we have limited research evidence suggesting the overall prevalence and manifestation of the disorder, as well as a lack of evidence-based best practices for diagnosing and measuring the presence and severity of anxiety disorders in adults with ASD.

Lastly, it is important to note that the studies described above, specifically those that focus on prevalence of any anxiety disorder, have relatively small samples sizes (Figure 1). Ghaziuddin (2008) presented prevalence on a sample of 28 participants. Both Bakken et al. (2010) and Joshi et al. (2013) had a sample size of about 60 ($N = 62$, Bakken et al., 2010; $N = 63$, Joshi et al., 2013). The largest samples were by Buck et al. (2014) and Lever and Geurts (2016), with samples sizes of 129 and 247, respectively. Croen et al. (2015) ascertained the largest sample, with a sample of 1507 participants. The small sample sizes in these studies reflect on the limited scope of prevalence findings, thus far.

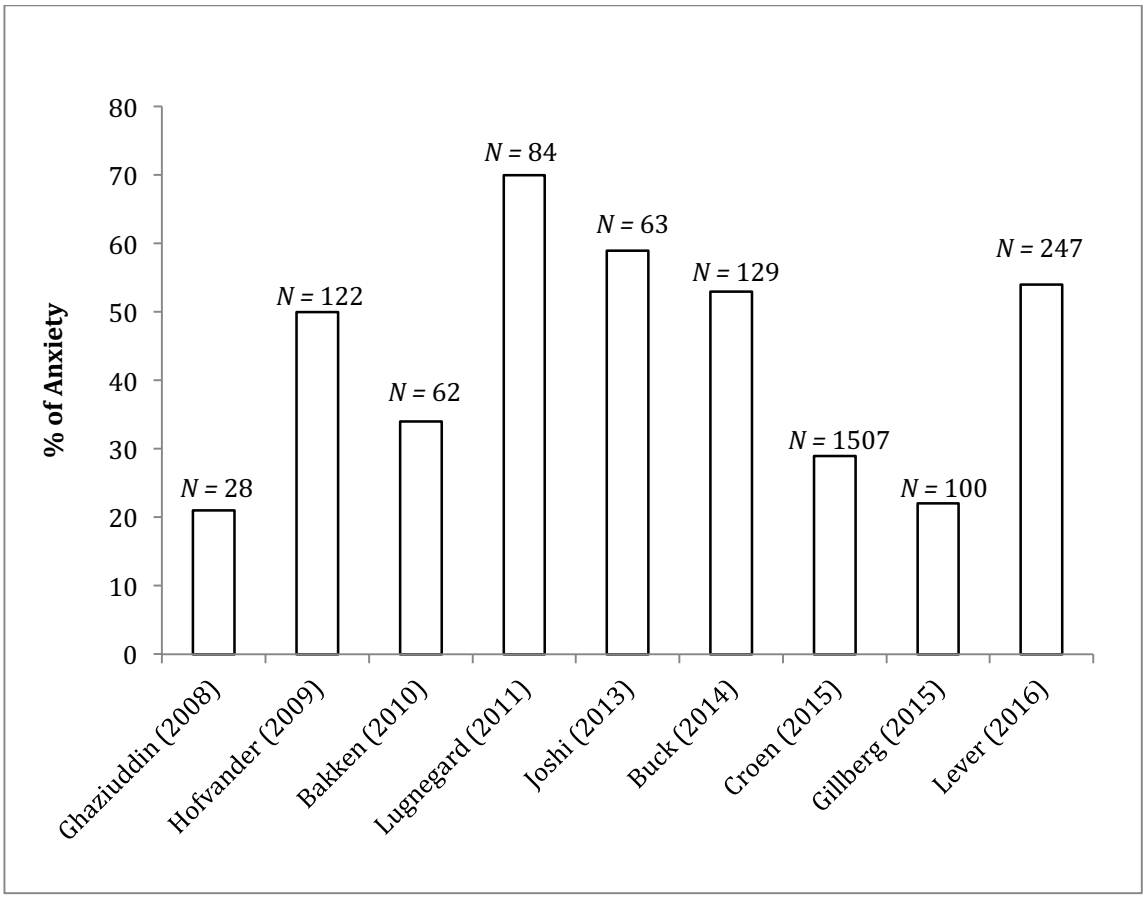

Figure 1. This figure depicts the both sample sizes and current estimates of co-occurring anxiety in adult with ASD.

Measuring Prevalence of Psychiatric Conditions

Given the difficulty in administering semistructured interviews to large samples of adults with ASD, the field is taking advantage of the ease and availability of electronic healthcare records to report on co-occurring psychiatric conditions (Croen et al., 2015). While studies using validated questionnaires have demonstrated prevalence rates of co-occurring psychiatric conditions and our evidence supports the clinical presence of these conditions, we have very few large-scale, epidemiological studies (Hare et al.; 2015; Maddox & White, 2015; Mazefsky, Folstein, & Lainhart, 2008). Croen et al. (2015) published the results on the health status of adults with ASD from medical billing

codes from electronic health records. While this method is time and cost efficient, there are mixed reports as to the validity of these data when compared to standardized assessments (Croen et al., 2015). Several other methods have been used to investigate the prevalence of psychiatric conditions (Centers for Disease Control, 2014; Kessler et al., 2005) and medical conditions (Campbell et al., 2011; Dismuke, 2005; Thiru, Hassey, & Sullivan, 2003); their strengths and weaknesses are presented below.

The National Comorbidity Survey Replication (NCS-R) is one of the largest and most cited studies investigating the prevalence of comorbid psychiatric conditions in adults. This study utilized a face-to-face structured clinical interview to assess for comorbid psychiatric conditions in over 14,000 participants. While this study used a gold standard assessment tool to measure prevalence, it was incredibly expensive and exhaustive to conduct (Kessler et al., 2005). The majority of autism studies do not have the type of funding resources to carry out this type of research study (Croen et al., 2015; Kohane et al., 2011). The Centers for Disease Control (CDC) uses The Autism and Developmental Disabilities Monitoring (ADDM) methodology to survey the prevalence of ASD in children. The ADDM methodology is an in-depth and comprehensive record review, where information based on the DSM-IV is abstracted and coded for potential ASD classification. While ICD-9 codes are used in the first wave of ascertainment, further record review and data abstraction are completed to determine case status (Centers for Disease Control, 2014).

The Centers for Disease Control (2014) and Kessler et al. (2005) used more extensive measures to examine prevalence of autism spectrum disorder, intellectual disabilities, and psychiatric conditions, but many studies have used diagnostic billing

codes for investigating medical conditions. Campbell et al. (2011) compared prospective in-person assessments of medical complications following surgery with retrospective ICD-9 codes and a record review. The ICD-9 based review captured a large number of medical events that had relatively little clinical importance. These events inflated the overall incidence rate of complications following surgery (Campbell et al., 2011). Dismuke (2005), on the other hand, found that many encounters in an imaging and diagnostics lab undercoded in regards to procedures. This was largely because the ICD-9 procedure codes were not needed for reimbursement. This study demonstrates the potential bias in diagnostic code reporting (Dismuke, 2005). Thiru, Hassey, and Sullivan (2003) systematically reviewed the quality of electronic medical record data in primary care, with hopes of determining if this data type could reliably be used in various types of research studies. Articles measuring the quality of data, particularly the completeness or accuracy of records, were selected and reviewed. Thiru, Hassey, and Sullivan (2003) found it relatively difficulty to measure reliability, validity, and sensitivity of these data due to the lack of similarity between studies or thorough reporting of data. They determined that these data reflected some consistency but should be used with caution (Thiru, Hassey, & Sullivan, 2003).

As seen, this type of data collection method presents with a high degree of variability (Dismuke, 2005; Hogan & Wagner, 1997; Thiru, Hassey, & Sullivan, 2003). Psychiatric conditions are by nature more difficult to assess and could be biased by clinician preference, hospital setting, or documentation practices (Croen et al., 2015; Kohane et al., 2011). The use of International Statistical Classification of Diseases and Related Health Problems, Ninth Revision (ICD-9) codes for surveillance research is

beneficial, as these codes have been sufficiently reviewed and described, but these codes could be used to describe or bill for symptoms rather than actual diagnoses. While there is potential for bias, the utilization of ICD-9 diagnostic codes to investigate prevalence could provide the opportunity for a strong exploratory study, which could lead into more detailed studies (Kohane et al., 2011).

The Proposed Study

It is overwhelmingly clear that adults with ASD are not reaching optimal adult outcomes and individuals with ASD are experiencing high rates of co-occurring psychiatric conditions, specifically anxiety. Research on co-occurring anxiety in children with ASD has greatly increased over the years, but there is still little known about co-occurring anxiety disorders in adults with ASD and the impact this debilitating comorbid condition has on adult outcomes. There are several limitations of the literature base thus far. Due to the complexity of diagnosing comorbid conditions, many with overlapping symptoms, studies using in-person semistructured interviews are limited to small sample sizes. In order to gain a larger sample size, several researchers have used survey data from medical billing codes in electronic healthcare records. This methodology is utilized in other areas of medicine, but while time and cost efficient, it is unclear as to whether these records compare to the gold standard of psychiatric condition assessment. The current study provides a unique opportunity to compare participant data on co-occurring anxiety from a gold standard semistructured interview with data extracted from billing codes in electronic healthcare records. The prevalence of co-occurring anxiety will be described in this adult population and associations between the presence of comorbid

psychiatric condition and adaptive functioning will be measured.

Research Questions

1. How reliable is the use of diagnostic billing codes from electronic healthcare records for describing co-occurring anxiety in adults with ASD?
2. What are the strengths and weaknesses of billing data for describing co-occurring conditions in individuals with ASD?
3. What is the prevalence of co-occurring anxiety in adults with ASD?
4. How do the types of anxiety disorders expressed by adults with ASD compare to the general population?
5. What is the association between the presence of co-occurring anxiety in adults with ASD and their adaptive functioning?

METHODS

The aim of this dissertation was to enhance our understanding of co-occurring anxiety in adults with ASD and evaluate the validity of using diagnostic billing codes to present prevalence of anxiety in this population. Three studies using a large participant cohort, with subsequent subcohorts, were conducted. The first study aimed to evaluate the validity of using diagnostic billing codes to study the psychiatric status of participants with ASD. This growing trend provides a cost- and time-efficient method of surveying large samples to improve our understanding of co-occurring anxiety in adults with ASD; however, how this information compares to gold standard assessments, such as the Mini PAS-ADD, is unknown. This study was unique due to the sample of adults with ASD for whom we had both gold standard, semistructured assessments of psychiatric disorders and surveillance health data. Diagnostic billing codes were provided by the Utah Population Database and compared to the University of Utah's data that were comprised of semistructured interviews and questionnaires. The second study aimed to describe the prevalence of anxiety in adults with ASD using survey data from diagnostic billing codes. Given the validity found in the diagnostic billing code methodology, this study described the prevalence of anxiety in adults with ASD, presented the types of anxiety seen in this population, and compared rates of anxiety disorders in adults with ASD to the general population. Finally, the third study explored the relationships between co-occurring anxiety and intellectual functioning, adaptive behavior, and employment.

Participants

Sample Formulation

A large sample of participants identified with ASD was ascertained through the University of Utah Autism Research Program to conduct the three studies in this dissertation. A list of University of Utah Autism Research Program study participants classified with ASD (N = 542) was provided to the Utah Population Database (UPDB) to be matched for medical record extraction from the two largest healthcare systems in Utah: The University of Utah Health Care (UUHSC) and Intermountain Healthcare (IHC). The UPDB also identified matched controls. Twenty-five participants matched to the UPDB had no medical record in either system and were subsequently removed from the ASD cohort, as there was no available source of healthcare utilization. Four hundred ninety-five participants were matched to controls (N = 2,475) with a one to five ratio by age, sex, and duration of Utah residence. Twenty-two participants with ASD matched to the UPDB and a medical record in either system, but UPDB information was insufficient to allow control matching (i.e., inability to determine presence and duration of Utah residence for Idaho residents). These 22 participants were included in the larger ASD sample but without controls. The total sample consisted of 2,992 participants. Three subsamples of participants, to be described later, were created for each study. Lastly, the overall ASD sample included several sets of sibling or parent-child relationships. For these familial pairs, the individual with the most complete record/Mini PAS-ADD was selected to participate. If no such distinction existed, the participant within the family was randomly selected. Subsequently, the total sample included 2,492 participants, 432 participants with ASD and 2060 controls.

Autism Spectrum Disorder Case Status Identification

The participants with ASD were ascertained through several recruitment methods within the University of Utah Autism Research Program reflecting the protocol of their original study (Figure 2). A large portion of the participants was first ascertained in the 1980s during the University of Utah and University of California, Los Angeles surveillance study of autism (N = 489). Two hundred forty-one participants in this collaborative study were classified with DSM-III autistic disorder during this time. One

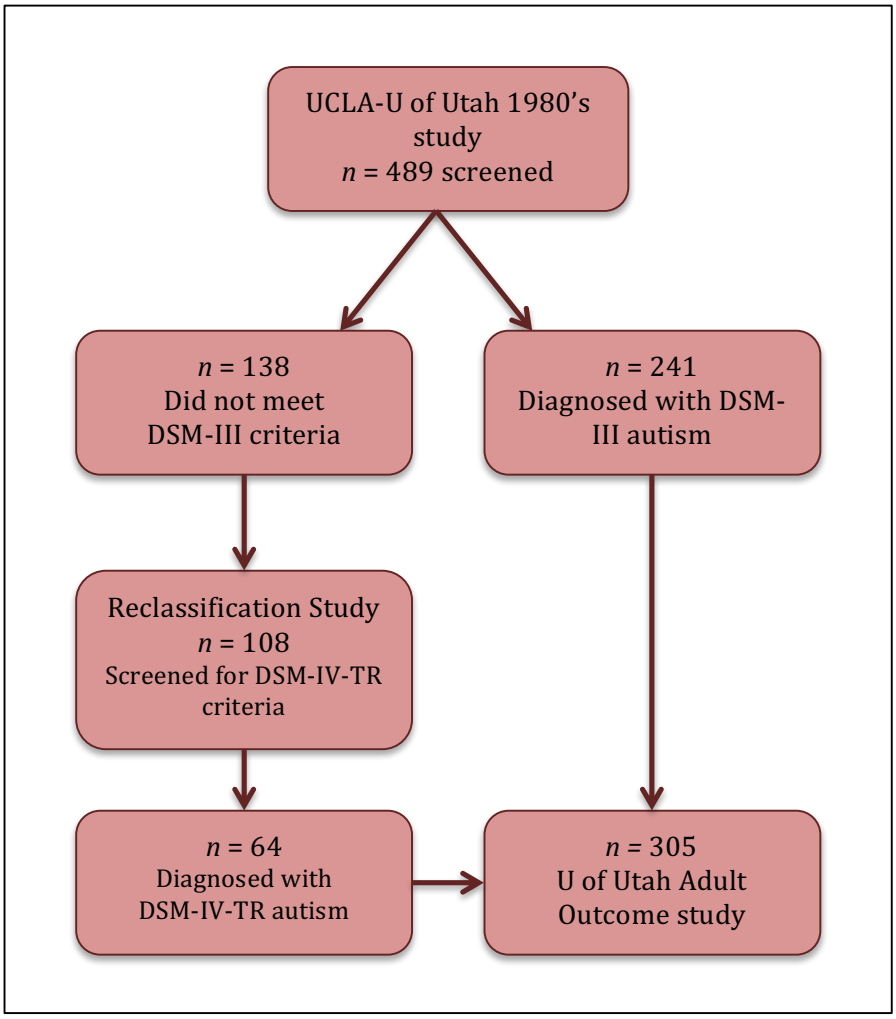

Figure 2. This figure depicts ascertainment for the University of Utah Adult Follow-up study.

hundred thirty-eight did not meet diagnostic criteria. Beginning in 2006, University of Utah researchers were interested in the impact of the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; American Psychiatric Association, 2000) criteria on those participants who did not meet DSM III autistic disorder criteria. The Centers for Disease Control and Prevention's Autism and Developmental Disabilities Monitoring Network methodology was then used to reassess these participants. Sixty-four participants were reclassified with DSM-IV-TR criteria. The sample, consisting of the original participants identified with ASD and those reclassified, were contacted for potential participation in the adult follow-up study (N = 305). One hundred eleven participants from the adult follow-up study were ascertained for this dissertation.

Participants were also ascertained through the University of Utah Transitions Study. This study was conducted to observe diagnostic status, life events, psychiatric comorbidity, and adaptive functioning of adolescents with ASD who were transitioning into adulthood. Eighty-four participants from that study were aged 18 and over and had a completed semistructured psychiatric interview; therefore, they were included in this study.

Lastly, participants were ascertained from several University of Utah Genetics studies. These studies were seeking to find genetic variations leading to susceptibility for ASD, investigating multiplex/extended pedigrees for familial links, and looking at genetic differences in Utah pedigrees. Four hundred thirty-two participants in the genetics sample were ascertained for this dissertation.

The participants in the Genetics and Transitions studies were ascertained through

connections with community resources and clinics, specifically the Autism Council of Utah, the University of Utah Autism Spectrum Disorder Clinic, and the Carmen B. Pingree Autism Center of Learning. Approved fliers were distributed at conferences and events where families with children with autism or their service providers were likely to attend. Databases consisting of participants in previous research studies also provided potential cases to contact.

Participants with ASD from these University of Utah Autism Research Program studies were ascertained as a single sample for this dissertation. Inclusion criteria for the overall sample consisted of participants identified with ASD and aged 18 years or older. Institutional Review Board approval was received from the University of Utah, Utah Resource for Genetic and Epidemiologic Research (RGE), and Intermountain Healthcare to link these University of Utah Autism Research Program studies' participants with their medical billing code data from the Enterprise Data Warehouses of the University of Utah and Intermountain healthcare systems.

Procedures

The University of Utah Institutional Review Board (IRB) approved the Principal Investigator of the University of Utah Autism Research Program, Hilary Coon, Ph.D., to access data from the UPDB. IRB approval was received from the University of Utah, Utah Resource for Genetic and Epidemiologic Research (RGE), and Intermountain Healthcare to link University of Utah Autism Research Program studies' participants with their medical billing code data from the Enterprise Data Warehouses of the University of Utah and Intermountain healthcare systems.

Design

This dissertation consisted of three retrospective cohort studies on adults with ASD, to investigate co-occurring anxiety in this population. The sample was compared to a cohort of age- and sex-matched controls. The retrospective study design was utilized to collect diagnostic codes from medical records and data collected in previous research studies. Retrospective medical record data were compared to an in-person measure of co-occurring anxiety. These data were compared to medical record data collected on the control cohort. Lastly, retrospective data from research studies were used to compare co-occurring anxiety to factors of employment, and intellectual and adaptive abilities.

Data Analysis

Each study in this dissertation uses slightly difference statistical analyses, but the overall tests and their assumptions are described here. Descriptive analyses were conducted to present sample demographics such as sex, age, intellectual functioning, adaptive behavior, employment status, and vocational rehabilitation use. Chi-square tests of independence were used to measure the association between variables. This test was selected due to the categorical nature of the data used for this dissertation. In addition, the data were considered independent, as each item entry contributed to only one cell of the contingency table, and the expected frequencies were greater than 5. In cases where cell frequencies were less than 5, Fisher's exact tests were used. Since categorical data are not continuous, they cannot be normally distributed, making these analyses nonparametric. To match the nonparametric nature of the chi-square test, Spearman's correlation coefficient was used to assess the relationship between variables. Relative risk or odds n

ratio were calculated from contingency tables when the table was 2 x 2. Logistic regression was used to predict category membership. This test was chosen due to the data being categorical. Multinomial logistic regression was used to predict category membership when there were 2 or more categories in the outcome variable (i.e., employment status).

Measures

No formal or informal measures were used to collect information directly from participants in the control sample. Data on prevalence of co-occurring anxiety were based on one presence of an ICD-9 billing code corresponding to an anxiety disorder listed in Tables 1 and 2. Existing data of diagnostic billing codes were extracted from the Enterprise Data Warehouses of Intermountain Healthcare and University of Utah Health Care through linkage with the UPDB.

In-person or direct contact assessments were performed to obtain information on the following: current and past diagnostic status, intellectual functioning, adaptive behavior, prevalence of anxiety in the research cohort, and factors of employment. Based on family and individual's preference, assessments were administered in their homes, the University of Utah Autism Research Program, or over the phone. Table 3 depicts the measures utilized in each of the three studies.

Diagnostic Assessments

Participants were assessed or reassessed and diagnosed at the time of ascertainment in order to obtain current or updated information on diagnostic status and

Table 2

International Classification of Diseases, 9th Revision Codes of Interest and Descriptions

Label	Code
Anxiety state, unspecified	300.00
Panic disorder without agoraphobia	300.01
Generalized anxiety disorder	300.02
Other anxiety states	300.09
Hysteria, unspecified	300.10
Phobic disorders	300.20
Phobia, unspecified	300.20
Agoraphobia with panic disorder	300.21
Agoraphobia without panic disorder	300.22
Social phobia	300.23
Other isolated/specific phobias	300.29
Obsessive-compulsive disorders	300.30
Posttraumatic stress disorder	309.81
Overanxious disorder specific to childhood and adolescence	313.0

Table 3

Summary of Data Collected by Study

	Study 1	Study 2		Study 3
	ASD	ASD	Control	ASD
	Cohort 1	Cohort 2	Cohort	Cohort 3
Diagnostic Codes	X	X	X	X
In-person Measure of Anxiety	X	X	-	X
Intellectual Ability	X	X	-	X
Adaptive Behavior	X	X	-	X
Employment	-	-	-	X

presentation of ASD symptomatology. Participants were assessed with the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and the Autism Diagnostic Interview – Revised (ADI; Lord, Rutter, & LeCouteur, 1994). Three hundred sixty-four participants were assessed with the ADOS. Eleven participants were untestable due to severe interfering behaviors, blindness, or extremely limited abilities. Four participants refused testing and 1 participant was out of the region. In 259 cases, a parent or caregiver participated in completing the ADI. Due to the complexity and time requirements in administering the ADI and ADOS, the remaining participants (n = 41) were classified with ASD using the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005) and the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003). The SRS is a 65-item, parent-rated questionnaire that assesses the child's ability to socially engage with others. This psychometrically sound (internal consistency alpha =

0.93-.97; Constantino & Gruber, 2002) assessment consists of five subscales that assess autistic fixations/preoccupations, social awareness, capacity for reciprocal social responses, social information processing, social motivation, and autistic fixations/preoccupations. Higher scores on this assessment indicate greater social skill impairments, highly suggestive of an autism spectrum disorder, and imply more severe degrees of impairment. While the SRS provides scores for each subscale, the total score was used for this study. The SRS was used as a screening tool during the recruitment phase and to obtain a quantitative measure of ASD (n = 319). The Social Communication Questionnaire (SCQ) is a parent/caregiver-report screening measure consisting of 40-items to assess symptomatology associated with autism spectrum disorder. Originally designed as a comparison screening measure for the Autism Diagnostic Interview-Revised (ADI-R), the SCQ consists of two measures, Current and Lifetime, and provides a cutoff score, which indicates whether an individual is likely to have an ASD. For this study, the SCQ was used to screen participants for an ASD (n = 222) and determine whether or not they required additional testing or if they could be considered to have an ASD based on the total score in combination with SRS results. The SCQ has research validity (factor analyses α = .26-.73 and item validity α = .53-.64).

The Autism Diagnostic Interview-Revised (ADI-R) is a comprehensive interview that has been proven very useful in evaluating individuals aged 2 years and older for an ASD diagnosis. The ADI-R evaluates three functional domains: language and communication; reciprocal social interactions; and restricted, repetitive, and stereotyped behaviors and interests. A trained clinician administers the ADI-R and interviews a parent or caregiver who is familiar with the developmental history and current behavior

of the individual being evaluated. The ADI-R is known to be a valid and reliable instrument (reliability $\alpha = 0.62$-$.89$; Lord, Rutter, & LeCouteur, 1994).

Anxiety Measures

The Mini PAS-ADD Clinical Interview is an abbreviated version of the Psychiatric Assessment Schedule for Adults with Developmental Disability (PAS-ADD; Moss et al., 1998). This psychiatric diagnostic tool contains 86 items and was used to assess co-occurring psychiatric disorders. The Mini PAS-ADD was designed for adults who have intellectual disability and is comprised of items based on the ICD-9 diagnostic algorithms for psychiatric disorders. Traditionally, caregivers are administered this semistructured interview by a trained mental health professional. In our study, a psychologist, psychology graduate student, or trained nurse administered the interview. The Mini PAS-ADD includes seven core symptom domains: depression, expansive mood (hypomania/mania), anxiety disorder, obsessive-compulsive disorder (OCD), psychosis, and unspecified disorder. The scoring algorithm incorporates the degree of impairment that is attributable to symptoms being assessed. Both current (preceding 4 weeks) and lifetime presence of symptoms were queried. Several studies have supported the use of the Mini PAS-ADD in examining psychiatric disorder prevalence in populations with ID (Devine, Taggart, & McLorian, 2009; Holden & Gitlesen 2004; Prosser et al., 1998). Sensitivity for the Mini PAS-ADD was found to range between 40-80% (Janssen & Maes, 2013) or 100% (Devine, Taggart, & McLorian, 2009). Specificity was found to be 77% (Devine, Taggart, & McLorian, 2009) or between 71-100% (Janssen & Maes, 2013). Internal consistency (.48 –. 95; Prosser et al., 1998) and interrater reliability (.77 –

.91; Prosser et al., 1998) have also been observed. One hundred ninety-four participants who completed the Mini PAS-ADD linked to the medical billing codes database. In order to reflect the historical nature of data represented by the medical billing codes query, the Mini PAS-ADD lifetime presence of co-occurring disorders was used.

Diagnostic Codes

Diagnostic codes corresponding to anxiety disorders were collected from medical billing records to evaluate the presence of co-occurring anxiety. The International Classification of Diseases, Ninth Revision (ICD-9) and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM; Medicore, 1996) were both widely used in the two medical systems from which medical record data were collected. Codes corresponding to anxiety disorders were collected from the ICD-9 and ICD-9-CM.

Intellectual Ability

Participants of the Autism Research Program received standardized and individually administered tests to measure intellectual and cognitive abilities. These assessment measures differed due to the study in which the participant was ascertained and the time point at which the data were collected. The Full Scale standard scores were collected from each test to represent an estimate of cognitive abilities. It is known that an individual's Full Scale score from one measure of intellectual ability may not be the same on another; however, this information was collected and pooled to capture an estimate of participant ability. The following assessment measures were used: Mullen Scales of Early Learning (Mullen; Mullen, 1995; $n = 50$); Differential Ability Scales (DAS; Elliot, 1990;

n = 68); Leiter International Performance Scale (Leiter-R; Roid & Miller, 1997; *n* = 5); Stanford-Binet Intelligence Scales, Fifth Edition (SB5; Roid, 2003; *n* = 32); Wechsler Intelligence Scale for Children – Third Edition (WISC-III; Wechsler, 1991; *n* = 11); Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997; *n* = 46); Wechsler Adult Intelligence Scale - Fourth Edition (WAIS-IV; Wechsler, 2008; *n* = 88); Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999; *n* = 4). When possible, the most recently obtained score from a Wechsler measure was used. If a score from a Wechsler measure was missing or incomplete, the next most recent and score was accepted. These combined scores provide a description of cognitive and intellectual abilities across the participants.

Adaptive Behavior

The Vineland Adaptive Behavior Scales – Survey Edition (VABS; Sparrow, Balla, & Cicchetti, 1984) and Vineland Adaptive Behavior Scales, Second Edition (Vineland-II; Sparrow, Cicchetti, & Balla, 2005) were used to assess adaptive behavior in adulthood. The VABS and VABS-II are individually administered measures for individuals aged birth through 90. They are used to assess adaptive behavior in the domains of Communication, Daily Living Skills, Socialization, and Motor Skills, and provide an overall composite score called the Adaptive Behavior Composite. The VABS has been proven reliable (internal consistency reliability score = 0.75 or greater; test-retest reliability score = 0.88-0.92) and valid. Three hundred four participants had a completed VABS (*n* = 99) or VABS-II (*n* = 205). Eighty-one participants had a completed record from both measures. Given that the VABS-II was published more

recently and provides a more current assessment of adaptive behavior in these participants, records with the VABS-II were prioritized.

Employment

The Adult Outcome Interview (AOI) is an informant-based interview developed for this study. It was used to assess participants' residential situations, work histories, use of social services, transportation, experiences with law enforcement, and chronic medical or co-occurring psychiatric conditions. One hundred eleven participants had a completed AOI. While the AOI provides a great deal of information, only employment information was used for this dissertation. Information regarding employment included factors such as employment status at the time of data collection, participation in a sheltered workshop or day program, number of jobs in lifetime, volunteer positions, and types/length of employment positions. Only information that reflected current employment status was used for this study.

Study 1

The aim of Study 1 was to validate the use of diagnostic billing codes to study the psychiatric health status of adults with ASD. Participant information from the University of Utah Autism Research Program was linked to data in the UPDB. The UPDB was used to match participants to their medical billing codes in order to obtain information on the presence of anxiety using surveillance data collected through medical billing codes. Surveillance data were then compared to the data collected through the participant's in-person assessments collected through the University of Utah.

Participants

From the larger sample of 432 participants with ASD who originated from University of Utah Autism Research Program studies, a subsample of participants was created. This subsample (Table 4) consisted of 194 participants for whom we had both a completed Mini PAS-ADD and diagnostic billing code data. Eighty-one participants were ascertained from the Transition's Study. Ninety-three were ascertained from the Adult Outcome or Adult Follow-up study. Twenty participants participated solely in the Genetics study. The age at the time of in-person data collection ranged from 16 to 59 (M = 30.48, SD = 9.4) and the age at the time of billing code ascertainment ranged from 22 to 64 (M = 36.13, SD = 9.59). One hundred sixty-five of these participants were male (85.1%).

Methods

Several procedures were conducted in order to obtain and process diagnostic billing code data for analysis. A list of University of Utah Autism Research participants was sent to the UPDB to be matched to their records in the database. A document was created that listed the University of Utah study identification number and UPDB unique identifier for cases and UPDB unique identifiers for controls. The document also contained a case identification number that linked cases to their controls. Once the participants were matched to the database, UPDB staff matched the participant's UPDB record to medical records in either the UUHSC or IHC databases. A document containing identification numbers of participants who matched to a UUHSC record was sent to an employee with UUHSC data warehouse access. A participant list was also sent to an

Table 4

Study Demographics

	N	Mean	Range	*SD*	*N* (%)
			Age		Male
Complete Sample	2472	31.14	(18-85)	11.4	2154 (87.1)
Complete ASD Cohort	432	31.01	(18-85)	11.4	376 (87.0)
Study 1					
ASD Cohort 1	194	36.13	(22-64)	9.6	165 (85.1)
Measures					
IQ	177	74	(13-140)	32.9	-
IQ Missing or Untestable	97	-	-	-	-
Mini PAS-ADD-Interview	194	-	-	-	-
Study 2					
Control Cohort	2060	31.14	(18-85)	11.4	1795 (87.1)
ASD Cohort 2	412	31.14	(18-85)	11.4	359 (87.1)
Study 3					
ASD Cohort 3	304	32.20	18-64	10.5	268 (88.2)
Measures					
IQ	304	80.81	13-138	31.2	-
VABS or VABS-II [a]	304	53.87	20-116	24.8	-
Employment Information	106	-	-	-	-

[a] VABS $n = 184$, VABS-II $n = 209$

employee at the IHC data warehouse containing participants who matched to IHC records. In addition, a list of diagnostic codes from the International Classification of Diseases, Ninth Edition (ICD-9) was sent along with each list of participants.

The two healthcare systems had slightly different ways of obtaining and providing data to me. The UUHSC data warehouse employee first conducted a quality check to identify invalid or missing ICD-9 codes. Some codes were invalid due to a misplaced

decimal, an additional numeral after the decimal, or the codes were missing additional numerals that severed as specifiers. The original list of ICD-9 codes was amended so that codes matched those in the system. A document with the code, the diagnostic label, and larger classification was created. For each participant with a UUHSC record, the UUHSC medical informaticist extracted ICD-9 billing codes in the list provided. A document that was created containing participant identification numbers, the specific ICD-9 billing code, the date of first and last diagnosis, and frequency of diagnosis was provided to the me. Some UUHSC data also contained a variable indicating where in the diagnostic list the ICD-9 billing code fell.

In order to analyze the data and compare it to the in-person assessment record, indicator variables were created to indicate the presence of each specific anxiety disorder (e.g., generalized anxiety, social anxiety, etc.). Indicator variables were also created to indicate the overall presence of anxiety. Specifically, three separate indicator variables were created to identify case status of anxiety. One variable that indicated any anxiety disorder inclusive of obsessive-compulsive disorder (OCD) was labeled "Anxiety/OCD." One variable indicated OCD only, "OCD." The final variable indicated the presence of any anxiety disorder excluding OCD, "Anxiety." These variables were labeled to indicate type of anxiety and that the data were from a UUHSC record.

The IHC data collection process differed slightly. A list of participants with identified IHC medical records, as well as the same list of ICD-9 codes provided to UUHSC, was sent to an IHC data warehouse employee. The ICD-9 code list consisted of all mental health disorder codes, as well as other medical conditions, to be used in further studies. Due to the large list of codes and large number of codes in the records, IHC

preferred to simplify the extraction process. Codes were grouped by category (e.g., depressive disorders, schizophrenia, anxiety state, OCD, social phobia, etc.) and data were provided to me already in the form of indicator variables. Variables provided to me indicated the presence of categorical mental health disorders and specific anxiety disorders. Case status was identified with a "1" or a "0." To create similar variables to the UUHSC data, I created three indicator variables for the overall presence of any anxiety disorder (Anxiety/OCD), OCD, or anxiety without OCD (Anxiety). These variables were labeled with a descriptor and that the data came from IHC sources.

Finally, the goal of this study was to increase the robustness of the dataset by incorporating data from both healthcare systems. Additional indicator variables were created to incorporate data from both systems. Variables indicated the presence of individual anxiety diagnoses, any anxiety diagnosis, OCD, and anxiety without OCD. These were labeled to indicate data from any medical record.

A similar process was done for data from the Mini PAS-ADD. The Mini PAS-ADD consists of numerous interview items aimed at identifying the presence of a symptom. Items are grouped into several scales for specific psychiatric conditions. The cutoff scores for each scale warrant a diagnosis. Final data were presented as a score for each scale; therefore, indicator variables were created to indicate whether or not a participant's score met the cutoff for an anxiety exclusive of OCD, OCD, or anxiety inclusive of OCD. These indicator variables were used to compare a participant's in-person case identification of anxiety to their medical record.

Data Analysis

SPSS Version 24 was used to conduct all statistical analyses. Descriptive analyses were conducted to present sample demographics such as sex, age, and presence of comorbid intellectual disability. The same was done with the Mini PAS-ADD. A chi-square test of independence was used to investigate the association between co-occurring anxiety found in the Mini PAS-ADD and diagnostic billing code data. Agreement of co-occurring anxiety across records was compared between participants using Spearman's rho. Values of 0.10 were considered to have a small effect, 0.30 were considered a medium effect, and 0.50 to have a large effect (Cohen, 1988). Lastly, specificity, sensitivity, positive predictive value, and negative predictive values were calculated to measure the performance of diagnostic billing codes.

Study 2

The second study analyzed the prevalence of co-occurring anxiety in adults with ASD. Given acceptable validity demonstrated in Study 1, surveillance data were used to describe co-occurring anxiety in adults with ASD ($N = 412$) and the age- and sex-matched general population controls ($N = 2060$). The categories of anxiety disorders present in adults with ASD were described and compared to that of controls. This study will provide the field with more information as to the categories of anxiety and prevalence of anxiety seen in adults with ASD. In addition, the presence of anxiety was compared between females and males within each sample and across the larger sample.

Participants

Study 2 consisted of 2472 participants (Table 4). The ASD sample for Study 2 was a subset of the larger sample. There were 20 participants in the larger ASD sample who had inadequate diagnostic billing code data availability for matched control selection and were subsequently removed for Study 2. The remaining ASD cohort for Study 2 consisted of 412 participants. There were 2060 participants in the control cohort. The mean age of the entire sample was 31.14 (range = 18-85, *SD* = 11.4). The cohort was 87.1% male (*n* = 2154).

Methods

The aim of this study was to compare the prevalence of co-occurring anxiety between adults with ASD and adults in a control cohort. Diagnostic code data from both healthcare systems were used to conduct these analyses. The indicator variables of Anxiety, OCD, and Anxiety/OCD described in the previous section were used to compare overall prevalence of the disorder. The data were cleaned and organized in order to describe and compare the prevalence of individual diagnostic codes.

Data from the UUHSC system were presented with ICD-9 diagnostic codes as the data. Data from IHC were presented as indicator variables based on the different ICD-9 codes requested. For example, one variable was labeled “Anxiety_ST_3000” to represent the presence of a diagnostic code for anxiety states. The UUHSC data were cleaned and organized to match this. I created UUHSC indicator variables for each diagnostic code with “1” indicating the presence of the code and “0” indicating the absence of a code from a record. Data from both healthcare systems were collapsed into one variable to

include data from both sources. The diagnostic code categories for other isolated or specific phobia, phobia unspecified, and agoraphobia without panic disorder had very small frequencies, with the frequency sometimes being 0 or 1. These diagnostic codes categories all indicated the presence of some phobia, so the data were collapsed into one larger category to indicate overall phobias.

Data Analysis

Descriptive analyses were conducted to present sample demographics, frequency of co-occurring anxiety, and frequency of anxiety disorder category. Frequencies of anxiety variables and anxiety disorders were compared between ASD and control participants with chi-square analyses. Fisher's exact test was used for comparisons when a variable had cell size less than 5. Comparisons were considered statistically significant at the 0.05 level. Frequencies of anxiety variables and anxiety disorders were also compared between males and females with chi-square analyses. Odds ratios were calculated to reflect risk between the larger groups and sexes.

Study 3

The purpose of Study 3 was to evaluate the association between the presence of co-occurring anxiety and factors of adaptive functioning in adults with ASD, specifically employment status, and intellectual and adaptive behavior. Association between these factors and presence of co-occurring anxiety was explored. A significant association could suggest the impact of co-occurring anxiety on adult outcomes.

Participants

The Study 3 sample consisted of the entire ASD sample (Table 4; *N* = 304). The age of these participants ranged from 18 to 64 (*M* = 32.20, *SD* = 10.47). The sample was 88.2% male. Inclusion criteria for this sample included completed measures of intellectual functioning and adaptive behaviors. The average Full Scale IQ was 80.81 (range = 13-138, *SD* = 31.19). The VABS and VABS-II were used in this study. The average Adaptive Behavior Composite score from the VABS or VABS-II was 53.87 (range = 20-116, *SD* = 23.79). One hundred six participants had a completed AOI, which provided information on employment.

Methods

The sample was determined by the presence of both a completed assessment of intellectual functioning and adaptive behavior. These participants were identified from the larger same of 432 participants. Indicator variables were created to indicate the presence of co-occurring anxiety. Data from both diagnostic billing codes and the Mini PAS-ADD were used to indicate case status. Data from the Mini PAS-ADD were prioritized due to the more comprehensive nature of interview. Diagnostic code data were used when a Mini PAS-ADD was missing, as was the case for 110 participants.

Data Analysis

Descriptive analyses were conducted to present factors of adaptive functioning. Chi-square analyses were conducted to explore the relationship between prevalence of co-occurring anxiety and adaptive functioning outcomes. Comparisons with *p* values less

than 0.05 were considered statistically significant. Effect sizes were measured by odds ratios (OR) and 95% confidence intervals (95% CI). Frequencies of anxiety were compared between participants with an intellectual disability and those without using chi-square analyses.

RESULTS

Demographics

Data were collected on 432 participants with ASD and 2060 control participants. The research questions were answered through three different studies, all using different subsamples. Demographics for the full sample, as well as subsamples, are displayed in Table 4.

The sample for Study 1 consisted of 194 participants who had both diagnostic code data from medical billing records and a complete Mini PAS-ADD. Lifetime diagnosis from the Mini PAS-ADD was used to represent case status for co-occurring anxiety. The age ranged from 22-64, $M = 36.16$, $SD = 9.59$, and there were 165 male participants (85.1%). Intellectual quotients were available for 177 participants. The average IQ was 74 (range=13-140, $SD = 32.91$). Sixteen participants were untestable but estimated to have severely limited intellectual and verbal abilities. Intellectual quotients could not be obtained on 1 participant because the family declined consent to in-person assessments but agreed to complete questionnaires that could be completed over the phone. One hundred forty-two participants (73.2%) were White and the race of 52 participants was unknown.

Sample 2 consisted of a subsample of participants from the larger ASD cohort and a control cohort matched based on age, sex, and duration of time living in Utah. There were 412 participants in the ASD cohort and 2060 participants in the control cohort. The

mean, range, and standard deviation for age was the same for both cohorts, *M* = 31.14, 18-85, *SD* = 11.5. Eighty-seven percent of samples were male, with 1795 male participants in the control cohort and 359 male participants in the ASD cohort. Diagnostic code data we available for each participant and no other measures were used with these samples.

The sample for Study 3 consisted for 304 participants from the larger ASD cohort. This sample was created based on participants with a completed record of intellectual and adaptive behavior. The mean age was 32.30 (18-64, *SD* = 10.47) and 88.2% (*n* = 268) participants were male. Diagnostic code data were available for all participants. All 304 participants had an estimated intellectual quotient. The mean IQ was 32.30 (13-138, *SD* = 31.19). All participants in this sample have a completed record of adaptive behavior using either the VABS or VABS=II. Data from the VABS were only used when the VABS-II was missing, resulting in the use of data from 209 VABS-II and 99 VABS. The Adaptive Behavior Composite was used to represent overall adaptive behavior abilities. The average Adaptive Behavior Composite standard score was 55.87, ranging from 20-116, *SD* = 24.79. Information on employment factors, use of vocational rehabilitation services and employment status, was collected on 106 participants.

Research Question #1

How reliable is the use of diagnostic billing codes from electronic healthcare records for describing co-occurring anxiety in adults with ASD?

Diagnostic codes are used to present the prevalence of medical and psychiatric conditions in the general population. Researchers are beginning to use diagnostic codes to

investigate and present the prevalence of conditions in participants with ASD. These data provide an efficient and cost-reductive way to collect data, but the reliability and validity of these data has yet to be studied. In order to investigate this concept, through the sample and procedures of Study 1, diagnostic code data were compared to data from an in-person semistructured interview. Results from these analyses are listed in Table 5 and described below.

Association Between Diagnostic Codes and Mini PAS-ADD

Chi-square tests were used to test for association between diagnostic code case status and Mini PAS-ADD lifetime diagnostic case status for Anxiety, OCD, and Anxiety/OCD. Significant associations were found between diagnostic code case status and the Mini PAS-ADD case status for Anxiety, χ^2 (1, N = 194) = 4.5, p = .035; OCD, χ^2 (1, N = 194) = 14.6, p < .001; and Anxiety/OCD, χ^2 (1, N = 194) = 3.91, p = .048. While associations were found between diagnostic code case status and Mini PAS-ADD case status, I sought to determine the relationship between these variables. Spearman's correlation coefficient was used to explore this relationship. The Spearman's correlation coefficient for Anxiety/OCD met significance (p = .048) and yielded a weak correlation (r_s = .14). Spearman's correlation coefficient for Anxiety was statistically significant indicating a significant, yet weak correlation (p = .035; r_s = .15). Lastly, Spearman's correlation coefficient for OCD had the strongest significance and a moderate correlation (p < .001; r_s = .27). The correlation for OCD held the strongest significance and had the largest effect.

Table 5

Association between diagnostic billing code case status and Mini PAS-ADD case status

Diagnostic billing code	Mini PAS-ADD (N = 194) Case (+)	Case (-)	p	Spearman's	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Anxiety								
Case (+)	62	32	0.035	0.15[b]	54.9	60.5	66.0	49.0
Case (-)	51	49						
OCD								
Case (+)	25	15	0.000	0.27[a]	35.2	87.8	62.5	70.1
Case (-)	46	108						
Anxiety/OCD								
Case (+)	78	28	0.048	0.14[b]	59.5	55.6	73.6	39.8
Case (-)	53	35						

[a] Correlation significant at the 0.01 level (2-tailed)

[b] Correlation significant at the 0.05 level (2-tailed)

Validity of Diagnostic Billing Codes

The first aim of Study 1 was to measure the association and relationship between the diagnostic code case status and Mini PAS-ADD case status. If associations were found, as they were, the second aim of Study 1 was to measure the validity and evaluate strengths and weaknesses of using diagnostic codes to present the prevalence of co-occurring anxiety. More specifically, I was interested in whether or not diagnostic codes were capturing co-occurring anxiety similarly to the capture of an in-person semistructured assessment. Specificity and sensitivity were calculated to reflect the validity of using diagnostic codes to evaluate the presence of co-occurring anxiety disorders in adults with ASD (Table 5). The Lifetime diagnostic status from the Mini PAS-ADD was used as the standard for all comparisons due to its established metrics. Diagnostic code case status was compared to Mini PAS-ADD case status for all variables: Anxiety, OCD, and Anxiety/OCD.

The sensitivity estimate for Anxiety was 54.9%. This indicates that diagnostic code data detected about 55% of the participants with an anxiety disorder, as determined by the lifetime diagnostic status from the Mini PAS-ADD. This estimate suggests that diagnostic codes detected only half of the participants with anxiety. The specificity estimate was slightly higher at 60.5%. Of the participants who had a negative Mini PAS-ADD case status for anxiety, 60% also had a negative case status for anxiety from diagnostic codes. These estimates suggest that diagnostic codes capture just over half of the participants with anxiety and capture slightly more participants without an anxiety disorder.

For OCD, sensitivity and specificity estimates suggested a highly specific test,

with a specificity estimate of 87.8%. The sensitivity was low, 35.2%, meaning that diagnostic codes detected 35% of participants with OCD. This low sensitivity estimate corresponded to a high specificity estimate, as 88% of the participants without OCD had no diagnostic codes for OCD. The high specificity estimate suggests that diagnostic codes are highly specific in identifying participants without OCD.

Lastly, when Anxiety and OCD were combined into the variable Anxiety/OCD, there was an interesting switch. The sensitivity estimate, 59.5%, increased and the specificity estimate decreased, 55.6%. When the variables were combined, diagnostic codes were more sensitive to detecting the presence of any anxiety disorder. This value was still rather low and a moderate proportion of the sample with anxiety was undetected; however, the value was approaching a more acceptable level. When combined, diagnostic codes for anxiety are more sensitive and capture more participants with the disorder. The lower specificity estimate suggests that when the variables are combined, diagnostic codes are less specific in detecting an anxiety disorder.

Research Question #2

What are the strengths and weaknesses of billing data for describing co-occurring conditions in individuals with ASD?

This question is largely answered in the discussion section, but some results reflecting investigation of this question are presented here. Study 1 procedures were used to calculate positive predictive values (PPV) and negative predictive values (NPV) to reflect some strengths and weaknesses of using billing data to describe co-occurring conditions (Table 5). PPV is the proportion of participants with a positive case status

(presence of a billing code) for anxiety who actually have anxiety based on the semi-structured Mini PAS-ADD. The NPV is the proportion of participants with a negative diagnostic case status (absence of a billing code) who truly do not have the disorder.

The PPV for anxiety was 66.0%, indicating that 66% of the participants with a positive diagnostic billing code for anxiety was correctly identified. The PPV for OCD implied that 62.5% of the participants with a positive diagnostic billing code for OCD actually had OCD. The highest PPV was for the combined variable of Anxiety/OCD. The PPV estimated that 73.6% of the participants with Anxiety/OCD truly had at least one of these disorders. The higher PPV estimate suggests what when the definition of anxiety is expanded to include a broader range of diagnoses, the predictive ability of diagnostic codes as a single entity increases.

Negative predictive values for Anxiety and Anxiety/OCD were 49.0% and 39.8%, respectively. The negative predictive value for OCD was much higher at 70.1%. NPVs suggest that when a participant was absent of a diagnostic code for OCD, they had a 70% change of not having the disorder. Alternatively, when a participant was lacking a diagnostic billing code for Anxiety or Anxiety/OCD, they were only 49.0% and 39.8% likely to truly be absent of an anxiety disorder.

Research Question #3

What is the prevalence of co-occurring anxiety in adults with ASD?

Study 2 aimed to present the prevalence of co-occurring anxiety in adults with ASD. The sample used to investigate the prevalence of co-occurring anxiety consisted of 412 adults with ASD. Data from diagnostic codes and Mini PAS-ADDs were used

separately to present prevalence. These data were also combined to present prevalence when either method was used. Diagnostic code data were used to report prevalence of specific anxiety disorders. These results are presented in Table 6.

Co-occurring Anxiety in Adults With ASD

The Mini PAS-ADD, a semistructured diagnostic interview, was used to present lifetime prevalence of co-occurring anxiety disorders. In the sample of 412 participants, 194 had a completed Mini PAS-ADD. Fifty-eight percent of the participants (*n* =113) had co-occurring Anxiety. Thirty-six percent of the sample (*n* = 71) met criteria for OCD. Lastly, 67.3% of the participants (*n* =131) had either Anxiety and/or OCD. Diagnostic code data were also used to analyze and present these findings (*n* = 412). Forty-six percent of the sample (*n* =191) had a diagnostic billing code representing an anxiety disorder. Fifty percent (*n* =206) of the sample had a positive case status for Anxiety/OCD. Seventy-three participants (17.7%) had diagnostic codes specific to OCD.

Mini PAS-ADD data and diagnostic code data were combined to present the prevalence of co-occurring anxiety when both data sources were considered. All 412 participants with ASD were included for this estimate. The prevalence of co-occurring Anxiety was 57.3% (*n* = 236). Prevalence for co-occurring OCD was 28.4% (*n* = 117). Finally, 61.7% of the sample (*n* = 254) had Anxiety/OCD.

In addition to reporting the overall prevalence of anxiety in adults with ASD, the aim of Study 2 was to investigate the presentation of anxiety disorders in this population. For example, it was questioned as to whether or not individuals with ASD more frequently experience one type of anxiety disorder over another. Anxiety state,

Table 6

Prevalence of anxiety disorders.

	Mini PAS-ADD (*N* = 194)		Combined ASD Data (*N* = 412)				
	N	%	*N*	%			
Anxiety	113	58.2	236	57.3			
OCD	71	36.6	117	28.4			
Anxiety/OCD	131	67.3	254	61.7			
	ASD (*N* = 412)		Control (*N* = 2060)				National Prevalence[a]
Diagnostic Code Data	*N*	%	*N*	%	*p*	OR (95% CI)	%
Anxiety	191	46.4	242	11.7	<0.000	6.49 (5.13-8.22)	-
OCD	73	17.7	16	0.8	<0.000	27.51 (15.82-47.83)	2.7
Anxiety/OCD	206	50.0	277	13.4	<0.000	6.44 (5.11-8.11)	33.7
Description							
unspecified anxiety state	179	43.4	219	10.6	<0.000	6.46 (5.08-8.21)	-
generalized anxiety disorder	81	19.7	64	3.1	<0.000	7.63 (5.39-10.81)	6.2
panic disorder without agoraphobia	14	3.4	24	1.2	0.001	2.98 (1.53-5.82)	5.2
social phobia	14	3.4	5	0.2	<0.000[b]	14.46 (5.18-40.36)	13.0
posttraumatic stress disorder	12	2.9	12	0.6	<0.000[b]	5.12 (2.28-11.48)	8.0
panic disorder with agoraphobia	7	1.7	3	0.1	0.000[b]	11.85 (3.05-46.02)	2.6
overanxious disorder specific child and adolescence	6	1.5	1	0.0	<0.000[b]	30.43 (3.65-253.42)	-
other phobia	5	1.2	5	02	0.015[b]	5.05 (1.46-17.52)	13.8
other anxiety states	4	1.0	7	0.3	0.095[b]	2.88 (0.84-9.87)	-
hysteria, unspecified	1	0.2	0	0.0	0.167[b]	-	-

[a] Kessler et al. (2012).

[b] Fisher's exact test was used due to cell sizes < 5.

unspecified, was the most common co-occurring diagnosis (n = 179, 43.4%). In fact, 93.7% of the participants with a diagnostic case status for anxiety had a diagnostic code for anxiety state, unspecified. Generalized anxiety disorder (n = 81, 19.7%) was the next most common co-occurring anxiety diagnosis. The remaining diagnoses were far less frequent, with proportions at 3.4% or less of the sample (n < 14).

Research Question #4

How does the prevalence and types of anxiety disorders experienced by adults with ASD compare to the general population?

Study 2 procedures were used to investigate this question. The prevalence of overall anxiety disorders and specific disorders was compared between adults with ASD and a control cohort. Diagnostic code data were used to present prevalence. The control cohort was considered the general population, but I was aware that the control cohort is largely specific to the Utah region. The results investigating this question are described below and in Table 6.

Prevalence Comparisons Between Adults With ASD and Controls

The prevalence of co-occurring anxiety in adults with ASD was compared to the prevalence of anxiety in an age- and sex-matched control cohort (Table 6). Chi-square associations were used to compare the frequency of co-occurring anxiety in adults with ASD with the frequency of anxiety in a control cohort. Significant associations were found for all three categories: Anxiety, χ^2 (1, N = 2472) = 284.677, p < .001, OCD, χ^2 (1, N = 2472) = 283.933, p < .001, and Anxiety/OCD, χ^2 (1, N = 2472) = 291.801, p < .001.

The proportion of ASD participants with a case status of Anxiety (46.4%) was significantly higher than the proportion of control participants with a case status of Anxiety (11.7%). The proportion of adults with ASD with a case status of OCD (17.7%) was significantly higher than that of the proportion of control participants with OCD (8%). In addition, the proportion of Anxiety/OCD was significantly higher in the ASD cohort (50.0%) than the control cohort (13.4%)

Similar to the ASD cohort, the most common diagnostic code for the control cohort was Anxiety State, Unspecified. The remaining disorders had proportions less than 3.1% ($n < 64$). Chi-square tests of association were used to test for associations in the proportion of specific anxiety disorders between the two cohorts. Significant associations were found for the following: anxiety state, unspecified, $\chi^2 (1, N = 2472) = 273.703$, $p < .001$; generalized anxiety disorder, $\chi^2 (1, N = 2472) = 170.382$, $p < .001$; panic disorder without agoraphobia, $\chi^2 (1, N = 2472) = 11.311$, $p = .001$. Fisher's exact tests were used when a cell size was less than 5, as was the case for the following categories, all with significant associations: social phobia, $\chi^2 (1, N = 2472) = 44.818$, $p < .001$; posttraumatic stress disorder, $\chi^2 (1, N = 2472) = 19.388$, $p < .001$; panic disorder with agoraphobia, $\chi^2 (1, N = 2472) = 20.563$; overanxious disorder, $\chi^2 (1, N = 2472) = 24.097$, $p < .001$; other phobia, $\chi^2 (1, N = 2472) = 8.032$, $p = .015$. The proportion of ASD participants with these anxiety disorders was significantly higher than that of control participants. Forty-three percent of the ASD cohort ($n = 179$) had a diagnostic code for anxiety state, unspecified compared to 10.6% ($n = 219$) of the control cohort. Three percent of the control cohort ($n = 64$) had a diagnostic code for generalized anxiety disorder, compared to 19% of the ASD cohort ($n = 81$). Associations for the remainder anxiety disorders were not

significant, as determined by Fisher's exact tests: other anxiety states, χ^2 (1, N = 2472) = 3.086, p = .095, and hysteria, unspecified, χ^2 (1, N = 2472) = 5.002, p = .167. It should be noted that while statistics were run to evaluate the association between the cohorts, some diagnostic codes had very small frequencies. In fact, the frequencies for some diagnostic codes were 0 or 1. In both the ASD and Control samples, the most common diagnostic codes were anxiety state, unspecified generalized anxiety disorder, and panic disorder without agoraphobia. The remaining diagnostic code categories had frequencies less than 15.

Odds ratios and confidence intervals were also calculated to reflect risk between the two cohorts. Adults with ASD were 6.44 times more likely to have anxiety than adults in the control cohort. Adults with ASD were 27.51 times more likely to have OCD than adults in the control cohort. Risk for specific co-occurring anxiety disorders ranged from 2.88 to 30.43. Overall, adults with ASD were much more likely to have a co-occurring anxiety disorder than adults in the control cohort.

Prevalence of Anxiety Compared to National Prevalence

The national prevalence of any or select anxiety disorders was visually compared to rates of anxiety in both the ASD cohort and the control cohort (Table 6). Upon visual analysis, rates of co-occurring anxiety in adults with ASD appear to be higher than those found in the general population. Rates of anxiety in the control cohort appear to be lower than proportions or the national sample. The national prevalence rates used for comparison were derived from a sample of adults ages 18-64. There were slightly more females in the national sample, but proportions were relatively even. The national sample

contained a narrower age range and consisted of far more females than in the samples used for this study. It is possible that if the demographics in the control cohort used for this dissertation were more similar to the demographics of the sample used for the national prevalence rates, the prevalence rates may be more consistent. In addition, prevalence rates for the national sample were derived from phone interviews surveying co-occurring disorders, which differed from the diagnostic code data used to present prevalence in our control cohort.

Prevalence of Anxiety Compared Between Sexes

In addition to comparing the prevalence of anxiety between the ASD and control cohort, the prevalence of anxiety was compared between males and females (Table 7). Comparisons were made between males and females in the ASD cohort and males and females in the control cohort. Chi-square tests were used to compare the frequency of anxiety found in women with the frequency of anxiety found in men, with significance at the .05 level. Fisher's exact tests were used when the cell size was less than 5.

For the ASD cohort, chi-square tests of association indicated significant associations for the major anxiety variables when the frequency of co-occurring anxiety was compared between sexes: Anxiety, χ^2 (1, N = 412) = 6.187, p = 0.013; OCD, χ^2 (1, N = 412) = 4.673, p = 0.031; Anxiety/OCD, χ^2 (1, N = 412) = 7.817, p = 0.005. For each variable, the proportion of females with anxiety was greater than the proportion of males with anxiety. Sixty-two percent of females had anxiety (n = 33), while 44.0% of males had anxiety (n = 158). In those with OCD, the proportion of females with OCD (n = 15, 28.3%) was higher than the proportion of males with OCD (n = 58, 16.2%). Lastly, 68%

Table 7

Prevalence of co-occurring anxiety by sex with diagnostic code data

	ASD *N* = 412					Control *N* = 2060				
	Male (*N* = 359)		Female (*N* = 53)			Male (*N* = 1795)		Female (*N* = 265)		
	N	%[a]	*N*	%[a]	*p*	*N*	%[a]	*N*	%[a]	*p*
Anxiety	158	44.0	33	62.3	0.013	203	11.3	39	14.7	0.108
OCD	58	16.2	15	28.3	0.031	12	0.7	4	1.5	0.146
Anxiety/OCD	170	47.4	36	67.9	0.005	230	12.8	47	17.7	0.028
Description										
unspecified anxiety state,	150	41.8	29	54.7	0.076	181	10.1	38	14.3	0.036
generalized anxiety disorder	69	19.2	12	22.6	0.559	53	3.0	11	4.2	0.294
social phobia	11	3.1	3	5.7	0.404[b]	4	0.2	1	0.4	0.498[b]
panic disorder without agoraphobia	10	2.8	4	7.5	0.074	20	1.1	4	1.5	0.538[a]
posttraumatic stress disorder	8	2.2	4	7.5	0.055[b]	10	0.6	2	0.8	0.660[b]
panic disorder with agoraphobia	5	1.4	2	3.8	0.224[b]	3	0.2	0	0.0	1.000[b]
child and adolescence overanxious disorder	5	1.4	1	1.9	0.565[b]	0	0.0	1	0.4	0.129[b]
other phobia	5	1.4	0	0.0	1.000[b]	4	0.2	1	0.4	0.498[a]
other anxiety States	3	0.8	1	1.9	0.425[b]	6	0.3	1	0.4	1.000[b]
hysteria, unspecified	1	0.3	0	0.0	1.000[b]	0	0.0	0	0.0	-

[a] Percent is within sex

[b] Fisher's exact test was used due to cell sizes < 5.

percent of females had Anxiety/OCD (n = 33) compared to 47.4% of males (n = 158). There were no statistical associations found between males and females with ASD when the frequency of individual diagnostic codes was compared between sexes.

In the control cohort, there was a significant association found between females and males with Anxiety/OCD, χ^2 (1, N = 2060) = 4.807, p = .028. The proportion of females with Anxiety/OCD (n = 47, 17.7%) was higher than the proportion of males (n = 230, 12.8%). No statistical associations were found between sexes for Anxiety or OCD, χ^2 (1, N = 2060) = 2.587, p = .108, χ^2 (1, N = 2060) = 2.119, p = .146. Chi-square tests indicated a statistical association between males and females for the diagnostic code of unspecified anxiety state, χ^2 (1, N = 2060) = 4.402, p = 0.036, as there was a higher proportion of anxiety in females (n = 38, 14.3%) than males (n = 181, 10.1%).

Research Question #5

What is the association between the presence of co-occurring anxiety in adults with ASD and their adaptive functioning?

Study 3 was the final study for this dissertation and used to evaluate this question. Study 3 aimed to evaluate the association between co-occurring anxiety and factors of adaptive functioning in adults with ASD, as well as factors of employment. I was interested in whether or not the proportion of co-occurring anxiety differed between levels of intellectual or adaptive behavior. In addition, I was interested in the association between co-occurring anxiety and factors of employment. The sample used for these evaluations consisted of 304 adults with ASD. This sample included only participants with completed assessment records of intellectual ability and adaptive behaviors.

Wilcoxon signed-ranks tests were used to examine whether or not the ASD cohort used in comparison to controls differed from the larger ASD cohort in sex or age. The Wilcoxon S-R tests indicated that the samples did not differ in either sex, $z = -.302$, $p = 0.763$, or age, $z = -.023$, $p = 0.982$. The presence of co-occurring anxiety was derived from both diagnostic billing codes ($n = 110$) and the Mini PAS-ADD ($n = 194$).

Co-occurring Anxiety and Intellectual Functioning

Chi-square tests of association were used to compare the frequency of co-occurring anxiety disorders in three levels of intellectual functioning: Normal ≥ 70, Mild intellectual disability = 50-69, Severe intellectual disability < 50 or untestable (Table 8). Significant associations were found for Anxiety and Anxiety/ODD when the frequency of co-occurring anxiety was compared with intellectual functioning: Anxiety, χ^2 (2, N = 304) = 6.54, $p = 0.038$, and Anxiety/OCD, χ^2 (2, $N = 304$) = 9.97, $p = 0.007$. No significant association was found when the frequency of co-occurring OCD was compared to the frequency of intellectual functioning categories, χ^2 (2, $N = 304$) = 4.724, $p = 0.094$. Among those with anxiety, the proportion of participants with severe ID or untestable intellectual functioning was 31.0% ($n = 53$). This proportion was higher than the 17.9% ($n = 21$) of participants without anxiety who also had severe ID. A similar association was found for participants with Anxiety/OCD, as the proportion of participants with Anxiety/OCD and severe ID was 31.4% ($n = 64$) and the proportion of participants without Anxiety/OCD and severe ID was 15.0% ($n = 15$). Among those without Anxiety, the proportion of participants with normal intellectual functioning was

Table 8

Association between intellectual functioning and behavior

		Anxiety			OCD			Anxiety/OCD		
	n (%)	Case + *n* (%)	Case - *n* (%)	*p*	Case + *n* (%)	Case - *n* (%)	*p*	+ *n* (%)	- *n* (%)	*p*
Full Sample	-	187 (61.5)	117 (38.5)		98 (32.2)	206 (67.8)		204 (67.1)	100 (32.9)	
Intellectual Functioning										
Normal (≥70)	185 (60.9)	105 (56.1)	80 (68.4)	0.038	51 (52.0)	134 (65.0)	0.094	113 (55.4)	72 (72.0)	0.007
Mild ID (50-69)	40 (13.2)	24 (12.8)	16 (13.7)		16 (16.3)	24 (11.7)		27 (13.2)	13 (13.0)	
Severe ID or Untestable <50)	79 (26.0)	58 (31.0)	21 (17.9)		31 (31.6)	48 (23.3)		64 (31.4)	15 (15.0)	
Adaptive Behavior Composite										
Normal (≥70)	89 (29.3)	48 (25.7)	41 (35.0)	0.004	17 (17.3)	72 (35.0)	0.000	51 (25.0)	38 (38.0)	0.000
Mild (50-69)	91 (29.9)	49 (26.2)	42 (35.9)		24 (24.5)	67 (32.5)		54 (26.5)	37 (37.0)	
Severe (<50)	124 (40.8)	90 (48.1)	34 (29.1)		57 (58.2)	67 (32.5)		99 (48.5)	25 (25.0)	
Communication										
Normal (≥70)	111 (36.5)	56 (29.9)	55 (47.0)	0.005	23 (23.5)	88 (42.7)	0.001	61 (29.9)	50 (50.0)	0.001
Mild (50-69)	53 (17.4)	32 (17.1)	21 (17.9)		15 (15.3)	38 (18.4)		34 (16.7)	19 (19.0)	
Severe (<50)	140 (46.1)	99 (52.9)	41 (35.0)		60 (61.2)	80 (38.8)		109 (53.4)	31 (31.0)	
Daily Living										
Normal (≥70)	83 (27.3)	52 (27.8)	31 (26.5)	0.045	24 (24.5)	59 (28.6)	0.089	56 (27.5)	27 (27.0)	0.013
Mild (50-69)	108 (35.5)	57 (30.5)	51 (43.6)		29 (29.6)	79 (38.3)		62 (30.4)	46 (46.0)	
Severe (<50)	113 (37.2)	78 (41.7)	35 (29.9)		45 (45.9)	68 (33.0)		86 (42.2)	27 (27.0)	
Social										
Normal (≥70)	90 (29.6)	47 (25.1)	43 (36.8)	0.009	22 (22.4)	68 (33.0)	0.000	51 (25.0)	39 (39.0)	0.003
Mild (50-69)	85 (28.0)	48 (25.7)	37 (31.6)		15 (15.3)	70 (34.0)		53 (26.0)	32 (32.0)	
Severe (<50)	129 (42.4)	92 (49.2)	37 (31.6)		61 (62.2)	68 (33.0)		100 (49.0)	29 (29.0)	

[a] ID = Intellectual disability

68.4% (n = 80), which is was higher than the proportion of participants with Anxiety and normal intellectual functioning (56.1%, n =105). The same was found in participants with or without Anxiety/OCD. The proportion of participants without Anxiety/OCD and normal intellectual functioning (n = 72, 72%) was higher than the proportion of participants with Anxiety/OCD and normal intellectual functioning (n = 113, 55.4%).

Logistic regression was used to predict case status for co-occurring anxiety based on category of intellectual functioning. Normal intellectual functioning was used as the reference variable and was compared to mild ID and severe ID/untestable. For the variables of Anxiety and Anxiety/OCD, having severe ID or untestable intellectual abilities significantly predicted co-occurring anxiety, b = .74, p = .012, b = 1.00, p = .002. Participants with severe ID or untestable intellectual functioning were 2.1 times more likely to have Anxiety and 2.7 times more likely to have Anxiety/OCD. Severe ID or untestable abilities did not significantly predict OCD, b = .53, p = .062. The category of Mild ID did not significantly predict and of the anxiety variables, Anxiety, b = .13, p = .707; OCD, b = .56, p = .122; Anxiety/OCD, b = .28, p = .449.

Co-occurring Anxiety and Adaptive Behavior

I was curious about the association of co-occurring anxiety and level of adaptive behavior. Chi-square tests of association were used for this analysis (Table 8). Adaptive behavior was measured by the VABS and VABS-II using the Adaptive Behavior Composite and the Communication, Daily Living, and Social scales. Standard scores were collapsed into three levels: normal ≥ 70, mild = 50-69, and severe < 50.

When the frequency of co-occurring Anxiety was compared between factors of

adaptive behavior, significant associations were found for the Adaptive Behavior Composite, χ^2 (2, N = 304) = 10.835, p = 0.004; Communication, χ^2 (2, N = 304) = 10.773, p = 0.005; Daily Living, χ^2 (2, N = 304) = 6.221, p = 0.045; and Social, χ^2 (2, N = 304) = 9.433, p = 0.009. For all comparisons between categories of adaptive behavior, participants with Anxiety were seen to have higher proportions of severe ID: Adaptive Behavior Composite, n = 90, 48.1%; Communication, n = 99, 52.9%; Daily Living, n = 78, 41.7%, and Social, n = 92, 49.2%. Of participants without anxiety, the proportion of participants with severe adaptive behavior was less: Adaptive Behavior Composite, n = 34, 29.1%; Communication, n = 41, 35.0%; Daily Living, n = 35, 29.9%; Social, n = 37, 31.6%. Similar to intellectual functioning, in participants without anxiety, the proportion of participants with normal adaptive behavior abilities was higher (Adaptive Behavior Composite, n = 41, 35.0%; Communication, n = 55, 47.0%), Daily Living (n = 31, 26.5%), and Social (n = 43, 36.8%) than the proportion of normal adaptive behavior in participants without Anxiety (Adaptive Behavior Composite, n = 48, 25.7%; Communication, n = 56, 29.9%), Daily Living (n = 52, 27.8%), and Social (n = 47, 25.1%).

When OCD was compared to factors of adaptive behavior, significant associations were found between sales of Adaptive Behavior Composite, χ^2 (2, N = 304) = 19.164, p < 0.001; Communication, χ^2 (2, N = 304) = 14.343, p = 0.001; and Social, χ^2 (2, N = 304) = 24.160, p = 0.009. There was not a significant association found for the Daily Living scale, χ^2 (2, N = 304) = 4.830, p = 0.089. The proportions followed the same trends as when anxiety was compared to adaptive behavior. Participants with OCD experienced higher proportions of also having severe ID (Adaptive Behavior Composite,

n = 57, 58.2%; Daily Living (*n* = 45, 45.9%), and Social (*n* = 61, 62.2%), where participants without OCD experienced lower proportions of having severe ID (Adaptive Behavior Composite, *n* = 67, 32.5%; Daily Living (*n* = 68, 33.0%), and Social (*n* = 68, 33.0%).

Significant associations were found when each adaptive behavior variable was compared to Anxiety/OCD: Adaptive Behavior Composite, χ^2 (2, *N* = 304) = 15.467, *p* < .001; Communication, χ^2 (2, *N* = 304) = 14.965, *p* = 0.001; Daily Living, χ^2 (2, *N* = 304) = 8.754, *p* = 0.013; and Social, χ^2 (2, *N* = 304) = 11.650, *p* = 0.003. The proportions were similar to those found in the other anxiety categories, with a higher proportion of participants with severe ID found in participants with Anxiety/OCD (Adaptive Behavior Composite, *n* = 99, 48.5%; Communication, *n* = 109, 53.4%), Daily Living (*n* = 86, 42.2%), and Social (*n* = 100, 49.0%) than in participants without Anxiety/OCD (Adaptive Behavior Composite, *n* = 25, 25.0%; Communication, *n* = 31, 31.0%), Daily Living (*n* = 27, 27.0%), and Social (*n* = 29, 29.0%) Likewise, a higher proportion of participants with normal adaptive behavior was found in participants without Anxiety/OCD (Adaptive Behavior Composite, *n* = 38, 38.0%; Communication, *n* = 50, 50.0%), Daily Living (*n* = 27, 27.0%), and Social (*n* = 39, 39.0%) than in participants with Anxiety/OCD (Adaptive Behavior Composite, *n* = 51, 25.0%; Communication, *n* = 61, 29.9%), Daily Living (*n* = 56, 27.5%), and Social (*n* = 51, 25.0%).

Logistic regression was used to predict whether a participant had anxiety given their normal, mild, or severe adaptive behavior abilities (Table 9, Table 10, Table 11). The category for normal adaptive behavior was compared to the categories of mild and severe adaptive behavior. Severe adaptive behavior on the Adaptive Behavior Composite

Table 9

Results of logistic regression: intellectual functioning and adaptive behavior as predictor of anxiety

	Anxiety			
	B (S.E.)	Sig	Exp(B)	95% CI
Intellectual Functioning [a]				
Mild ID (50-69)	.13 (.36)	.707	1.14	.57-2.29
Severe ID or Untestable (<50)	.74 (.30)	.012	2.10	1.18-3.75
Adaptive Behavior Composite [a]				
Mild (50-69)	-.00 (.30)	.991	1.00	.56-1.79
Severe (<50)	.82 (.29)	.005	2.36	1.27-4.01
Communication [a]				
Mild (50-69)	.40 (.34)	.234	1.50	.77-2.81
Severe (<50)	.86 (.27)	.001	2.37	1.41-3.99
Daily Living [a]				
Mild (50-69)	-.41 (30)	.173	.67	.37-1.19
Severe (<50)	.28 (.31)	.351	1.33	.73-2.41
Social [a]				
Mild (50-69)	.17 (.30)	.573	1.19	.65-2.15
Severe (<50)	.82 (.29)	.004	2.28	1.30-3.99

[a] Normal (≥70) = reference

Table 10

Results of logistic regression: intellectual functioning and adaptive behavior as predictor of OCD

	OCD			
	B (S.E.)	Sig	Exp(B)	95% CI
Intellectual Functioning [a]				
Mild ID (50-69)	.56 (3.62)	.122	1.75	.86-3.56
Severe ID or Untestable (<50)	.53 (.28)	.062	1.70	.97-2.96
Adaptive Behavior Composite [a]				
Mild (50-69)	.42 (.36)	.264	1.52	.75-3.07
Severe (<50)	1.28 (.32)	.000	3.60	1.91-6.80
Communication [a]				
Mild (50-69)	.41 (.38)	.284	1.51	.71-3.21
Severe (<50)	1.05 (.29)	.000	2.87	1.63-5.06
Daily Living [a]				
Mild (50-69)	-.10 (.33)	.752	.90	.48-1.71
Severe (<50)	.49 (.31)	.115	1.63	.89-2.98
Social [a]				
Mild (50-69)	-.41 (.38)	.273	.66	.32-1.38
Severe (<50)	1.02 (.30)	.001	2.77	1.53-5.12

[a] Normal (≥70) = reference

Table 11

Results of logistic regression: intellectual functioning and adaptive behavior as predictor of Anxiety/OCD

	Anxiety/OCD			
	B (S.E.)	Sig	Exp(B)	95% CI
Intellectual Functioning [a]				
Mild ID (50-69)	.28 (.37)	.449	1.32	.64-2.73
Severe ID or Untestable (<50)	1.00 (.324	.002	2.72	1.44-5.13
Adaptive Behavior Composite [a]				
Mild (50-69)	.08 (.30)	.782	1.09	.60-1.97
Severe (<50)	1.08 (.31)	.000	2.95	1.61-5.42
Communication [a]				
Mild (50-69)	.38 (.34)	.266	1.47	.75-2.88
Severe (<50)	1.06 (.28)	.000	2.88	1.67-4.98
Daily Living [a]				
Mild (50-69)	-.43 (.31)	.157	.65	.36-1.18
Severe (<50)	.43 (.32)	.183	1.54	.82-2.89
Social [a]				
Mild (50-69)	.01 (.30)	.972	1.01	.56-1.84
Severe (<50)	.52 (.28)	.060	1.68	.98-2.89

[a] Normal (≥70) = reference

and Communication scale significantly predicted Anxiety (b = .82, p = .005; b = .86, p = .001), OCD (b = 1.28, p < .001; b = .1.05, p < .001) and Anxiety/OCD (b = 1.08, p < .001; b = 1.06, p < .001). Mild adaptive behavior for the Adaptive Behavior Composite, Communication, or Social scales did not significantly predict any anxiety variable. Severe adaptive behavior on the Social scale significantly predicted Anxiety, b = .82, p = .004, and OCD, b = 1.02, p = .001, but not Anxiety/OCD, b = .52, p = .060. Neither category of adaptive behavior on the Daily Living scale predicted Anxiety, OCD, or Anxiety/OCD. Adults with ASD were 1.33-.360 times more likely to have anxiety or OCD given having severe adaptive behavior.

Co-occurring Anxiety and Employment Status

The association between anxiety and factors of employment was explored to reflect any potential impact anxiety could have on one's ability to gain employment. Factors of employment included employment status and whether or not a participant had accessed vocational rehabilitation services. Employment status was divided into three categories reflecting ones ability to be independently employed (Independent); maintain employment in a supported environment, such as with a job coach or within a sheltered workshop (Supported); or be unemployed (Unemployed), which also included participants who participated in a day program, reflecting their inability to supply income. In addition, multinomial logistic regressions were used to evaluate whether the presence of anxiety predicted participant case status for employment. Independent employment was used as the reference variable and compared to the other employment categories. The results of these analyses are presented in Table 12.

Chi-square tests of association were used to compare presence of anxiety to employment status. The associations were found to be significant for all anxiety variables: Anxiety, χ^2 (2, N = 106) = 8.585, p = .017; OCD, χ^2 (2, N = 106) = 14.676, p = .001; Anxiety/OCD, χ^2 (2, N = 106) = 12.789, p = .002). Of those with anxiety, the proportion of participants who were unemployed (n = 14, 19.7%) was higher than the proportion of participants without anxiety and unemployed (n = 6, 17.1%). Of participants without anxiety, the proportion of participants who were independently employed (Anxiety, n = 15, 55.6%; OCD, n = 24, 88.9%; Anxiety/OCD, n = 14, 51.9%) was higher than the proportion of participants with anxiety who were independently employed (Anxiety, n = 12, 44.4%; OCD, n = 3, 11.1%; Anxiety/OCD, n = 13, 48.15).

Table 12

Association and regression results of anxiety and employment

	Anxiety			OCD			Anxiety/OCD		
	Case + *n* (%)	Case - *n* (%)	*p*	Case + *n* (%)	Case - *n* (%)	*p*	Case + *n* (%)	- *n* (%)	*p*
Full Sample	71 (67.0)	35 (33.0)		61 (57.5)	45 (42.5)		78 (73.6)	28 (26.4)	
Associations									
Employment Status [a]									
Independent	12 (16.9)	15 (42.9)	.017	3 (6.7)	24 (39.3)	.001	13 (16.7)	14 (50.0	.002
Supported	45 (63.4)	14 (40.0)		32 (71.1)	27 (43.3)		50 (63.1)	9 (32.1)	
Unemployed	14 (19.7)	6 (17.1)		10 (22.2)	10 (16.4)		15 (19.2)	5 (17.9)	
Vocational Rehabilitation [a]									
Have used	9 (12.7)	8 (22.9)	.179	3 (6.7)	14 (23.0)	.024	9 (11.5)	8 (28.6)	.067
Have not used	62 (87.3)	27 (77.1)		42 (93.9)	47 (77.0)		69 (88.5)	20 (71.4)	
Regression	*B* (S.E.)	Sig.	Exp (B)	*B* (S.E.)	Sig.	Exp (B)	*B* (S.E.)	Sig.	Exp (B)
Employment Status [a]									
Independent (reference)									
Supported	-1.39 (.33)	.005	.25	-2.25 (.66)	.001	.11	-1.79 (.31)	.001	.17
Unemployed	-1.07 (.62)	.086	.34	-2.08 (.76)	.006	.13	-1.17 (.64)	.069	.31

[a] Sample size, $n = 106$

While the proportion of participants who had a co-occurring anxiety disorder and were independently employed was less than the proportion of participants without an anxiety disorder who were independently employed, these proportions only differed by a few percentage points. Within participants with Anxiety or Anxiety/OCD, the proportion of participants who were unemployed (Anxiety, $n = 14$, 70.0%; Anxiety/OCD, $n = 15$, 75%) was higher than that of participants without Anxiety or Anxiety/OCD who were unemployed (Anxiety, $n = 6$, 30.0%; Anxiety/OCD, $n = 5$, 25.0%). The difference between these proportions was much larger. Interestingly, of the number of participants who had OCD and were unemployed ($n = 10$, 50%) was the same as the number of participants who were absent of OCD and unemployed ($n = 10$, 50%). This sample of participants used for this analysis also had a far larger proportion of OCD (57%) than in the larger ASD cohort (28%).

Multinomial logistic regression analyses indicated that having OCD significantly predicted whether a participant was unemployed or in supported employment when compared to those who were independently employed. In those with Anxiety or Anxiety/OCD, a positive case status for either variable predicted whether the participant was in supported employment or independently employed. Participants who were in supported employment were more likely to have anxiety, where participants who were independently employed were less likely to have anxiety.

Chi-square tests of associations were used to compare the use of vocational rehabilitation and anxiety variables, specifically whether or not the participant had accessed vocational rehabilitation services. A significant association was found for a participant having used vocational rehabilitation and having OCD, $\chi^2 (1, N = 106) =$

5.100, $p = .024$, but no other anxiety variables: Anxiety, χ^2 (1, $N = 106$) = 1.805, $p = .179$; Anxiety/OCD, χ^2 (1, $N = 106$) = 4.439, $p = .067$. The proportion of participants without OCD who had used vocational rehabilitation ($n = 14$, 23.0%) was larger than the proportion of participants with OCD who had used services ($n = 3$, 6.7%). The proportion of participants without OCD who had not used vocational rehabilitation services ($n = 47$, 77.0%) was smaller than the participants with OCD who had not used services ($n = 42$, 93.9%).

DISCUSSION

General Discussion

Autism spectrum disorder affects an immense amount of individuals around the world. As diagnostic tools have improved, more and more individuals across the lifespan are being identified as having the disorder. The majority of research has been conducted on infants, children, and adolescents, but researchers are focusing efforts to investigate ASD in adulthood, particularly when it comes to outcomes, needs, and areas of strength (Baker, 2013). The current literature base shows that adults with ASD have worsened outcomes when compared to both their typically developing peers and adults with other developmental disabilities (Bakken et al., 2010; Gillot & Standen, 2007). This is even true when individuals with ASD have normal intellectual capabilities (Farley et al., 2009). Adults with ASD tend to have limited employment opportunities and outcomes. They are less likely to obtain higher education degrees, have fewer social and romantic relationships, have difficulty living independently, and have higher rates of co-occurring medical and psychiatric conditions (Buck et al., 2014; Farley et al., 2009; Howlin, 2000; Jones et al., 2015; Roux, Shattuck, Rast, Rava, & Anderson, 2015; Wei, Wagner, Hudson, Yu, & Shattuck, 2015). Given these factors, research on outcomes in adults with ASD is imperative to improving the lives of these individuals, determining service needs, and developing interventions or assistance programs.

Current research on adults with ASD indicates that these individuals frequently

experience co-occurring psychiatric conditions, such as depression, anxiety, and attention deficit hyperactivity disorder (de Bruin, Ferdinand, Meester, de Nijs, & Verheij, 2007; Buck et al., 2014; Howlin, 2000; Roy, Prox-Vagedes, Ohlmeier, & Dillo, 2015). It is well known that a single psychiatric condition can impact one's ability to complete everyday tasks and live independently. Research suggests that when an individual experiences co-occurring conditions, it can further impact their life outcomes (Mojtabai et al., 2015a; Mojtabai et al., 2015b). This is likely true when applied to adults with ASD, further indicating a need to put forth efforts to research this area (Vannucchi et al., 2014).

While current literature presents the prevalence of co-occurring psychiatric conditions in this population, the estimates widely vary between studies. Studies present proportions of co-occurring psychiatric conditions that range from 29 to 70% (de Bruin at al., 2007). These studies typically vary in the method of measuring co-occurring conditions, with some using screeners (Gotham, Brunwasser, & Lord, 2015) and others using in-depth interviews (Hofvander et al., 2009). These studies also widely vary in sample size and demographics, with the samples typically being rather small and restricted. Overall, researchers are calling for a better understanding of the prevalence and presentation of co-occurring psychiatric conditions in this population.

The current literature base is lacking studies with robust sample sizes. So far, only one study has presented co-occurring diagnoses in a sample larger than 400 (Croen et al., 2015). Croen et al. (2015) used diagnostic codes from medical billing records to present the prevalence of co-occurring medical and psychiatric conditions in a sample of over 1,000 individuals. Diagnostic codes are used in other areas of medical research to present the prevalence of various conditions. Using these diagnostic codes allows for an

affordable and efficient way to present prevalence estimates on a large number of individuals, given that these data are already collected and do not require additional in-person assessments or ascertainment. One limitation to the use of diagnostic billing codes is that the data are limited to when the healthcare system began collecting electronic medical records, as well as when they implemented the use of ICD-9 codes. Some electronic medical record systems date back to the 1960s, but the majority of robust records were documented in the 1990s and early 2000s (Atherton, 2011).

The study by Croen et al. (2015) was the first to present prevalence of co-occurring conditions in adults with ASD using diagnostic codes. The aim of the study was to capture a large sample of individuals with ASD and compare prevalence rates to a control cohort. The study contributed a large amount of information to the field and presented the first example of using diagnostic codes in this population (Croen et al., 2015). This method allows researchers to more easily investigate a larger number of individuals; however, the validity of these large medical data sets for this type of analysis is unknown.

This dissertation study aimed to investigate this concept. I had access to a large data set that (1) contained in-person assessments of intellectual and adaptive behavior, co-occurring psychiatric and medical conditions, and (2) was linked to the UPDB for matching with medical billing records of the two largest healthcare systems in Utah. This data set allowed me to compare the presence of co-occurring anxiety identified through an in-person semistructured interview to the presence of co-occurring anxiety identified through medical billing records. Also, it allowed the researchers to present the prevalence of co-occurring anxiety on a large sample of participants and compare these findings to

outcome variables. Overall, the aim was to improve our understanding of co-occurring anxiety in adults with ASD, as well as our understanding of research methods and data sources.

Main findings from these questions are discussed in the following sections. Overarching themes from the research findings are discussed as well. A larger concept appears to be an ongoing issue of co-occurring psychiatric condition identification and definition. In other words, there is a significant amount of variability in the prevalence of co-occurring anxiety based on its measurement methods. In addition, there are both clinical and investigation implications for this research, such as access to healthcare and service delivery or development.

Demographic Considerations

The ASD cohort used for this dissertation was comprised of participants from the three studies conducted through the University of Utah Autism Research Program. The ASD cohort consisted of participants with differing levels of intellectual functioning and adaptive behaviors, as well as a wide age range and a variety of ASD symptomatology. While the sample showed some diversity in abilities and ASD symptoms, it was also limited, given that a large number of participants were ascertained through a study originally conducted in the 1980s. This study, an epidemiologic survey conducted in the 1980s, aimed to investigate the prevalence of autism in Utah (Ritvo et al., 1989). The sample was identified using DSM-III criteria for autism. Twenty years later, investigators were interested in this population of participants, particularly as to what type of life outcomes they experienced and whether their symptom presentation and intellectual

abilities had changed (Farley et al., 2009). In addition, investigators were interested in the impact changes in DSM criteria for autism had on ASD case status of participants who originally did not meet DSM-III criteria for autism. Sixty-four participants were reclassified using CDC ADDM Network chart review methodology and reascertained for the follow-up study if they were originally or reclassified as having ASD (Miller et al., 2013). The cohort for this dissertation was primarily drawn from this follow-up study, providing a rich, longitudinal perspective of adaptive and intellectual ability, and recent outcomes from semistructured assessments of co-occurring psychiatric conditions, medical conditions, and employment outcomes. In addition to these individuals, participants were ascertained from a study investigating transition into adulthood and genetics of individuals with ASD (Farley et al., 2009). Participants from all three samples were collapsed into one sample for this dissertation and extraction of medical billing records.

This sample was very specific to the state of Utah and included a large number of participants with a classic presentation of ASD as well as a more contemporary understanding of the broader ASD spectrum as reflected in the IQ distribution among participants described in Table 12. For example, studies by Howlin, Mawhood, and Rutter (2000) and Helles, Gillberg, Gillberg, and Billstedt (2015) included a similar population of participants who were ascertained with inclusion criteria based on previous versions of the DSM. However, the majority of adult outcome literature utilized samples of adults who were ascertained in the 1990s or 2000s (Billstedt, Gillberg, & Gillberg, 2005; Barneveld, Taylor, Henninger, & Mailick, 2015). These samples comprise more participants with average intellectual abilities or less severe symptoms.

The sample was specific to the region of Utah, as a large majority was ascertained through the epidemiological survey study. This includes a large number of rural areas that tend to be somewhat secluded from healthcare resources. The participants had access to services in a growing metropolitan area, but this sample is likely to differ largely from a sample of participants ascertained in a larger, more established metropolitan area. Living in a rural setting could reduce a participant's access to services and potentially the quality of services they receive, yet these individuals may also experience better social outcomes in regards to their inclusiveness in their small communities and tightness of their social network. Previous reports on a subsample used for this dissertation suggested that the adults in this study had somewhat better social outcomes when compared to adults in other follow-up studies. It was hypothesized that the social support and structure provided by a local religious organization might have influenced more positive results (Farley et al., 2009).

Use of Diagnostic Codes to Present Prevalence

This study aimed to investigate the use of diagnostic codes to present prevalence of co-occurring psychiatric conditions. Large data, some of which consists of diagnostic codes from medical billing records, are more frequently used to investigate findings on adult outcomes. For example, Roux et al. (2015) published the National Autism Indicators Report: Transition Into Young Adulthood 2015 using data from a large database holding survey data from several studies. This report included, among several factors, service usage, health and mental health care, education, and employment (Roux et al., 2015). Currently, large data are mostly used to report social outcomes of adults

with ASD, with the exception of one study from Croen et al. (2015). The use of large data could be a cost- and time-efficient method of data collection, but it is unknown as to whether these are reliable. I aimed to evaluate how diagnostic codes compare to an in-person, gold-standard assessment of co-occurring anxiety for adults with intellectual disability. Along with the comparison between the two measures, I was interested in strengths and weaknesses of diagnostic codes for estimating the prevalence of co-occurring anxiety.

First, the comparison between diagnostic codes and the Mini PAS-ADD is discussed. The reliability of diagnostic codes is considered through tests of association and correlations. Validity is considered using estimates of sensitivity and specificity. Positive predictive values and negative predictive values are discussed in relation to probabilities of diagnostic codes correctly identifying co-occurring anxiety. Lastly, the overall strengths and weaknesses of diagnostic codes, as well as implications for clinical and research purposes are discussed.

Reliability of Diagnostic Codes

To investigate the reliability of diagnostic codes, diagnostic code data were compared to data from the Mini PAS-ADD, a semistructured clinical interview. Significant associations were found for each anxiety variable, indicating a relationship between the two data sources. The associations were significant when assessed at an alpha of 0.05. Specifically, *p*-values were as follows: OCD ($p < 0.001$), Anxiety ($p = 0.035$), and Anxiety/OCD ($p = 0.048$). These associations suggest that case status for diagnostic code data was related to case status for a gold standard measure of anxiety.

The relationship signifies that diagnostic code data could be used to present prevalence of co-occurring disorders, as there was some relationship between data. This relationship was also visible in the prevalence rates of overall co-occurring anxiety. When the measures were used independently to measure prevalence, the proportions were rather similar, suggesting similarities in the measurement tools. The associations and visual similarities suggest concordance between the two measures; however, more research in this area is warranted given two of the significance values approached the .05 limit. Statistical tests, like the chi-square, are subjective to sample size. A varying sample size could impact the significance of the Pearson chi-square.

In addition to chi-square associations, Spearman's correlation coefficients were calculated between the two data sources. If significant, the strength of the relationship was evaluated based on Cohen's recommendations (Cohen, 1988). Significant correlation coefficients were found for all variables but the correlations were weak, with the correlation for OCD approaching moderate strength. The weak correlations signify poorly aligned data between measures. While there is a significant relationship between the data sources, they do not appear to be measuring the same concepts.

No other studies related to autism have been conducted in this area; however, in other studies comparing two measurements, researchers decided that comparable correlations were insufficient and suggested that the measures were described phenomena. Indeed, this finding reflects the larger issue of measurement differences between billing code data and in-person, semistructured assessments designed for adults with a developmental disability. Measurement differences may be attributable to a variety of issues such as the timing of the Mini PAS-ADD administration in relation to date

range of billing code ascertainment, distinctions in the scope of practice between community providers (diagnostic billing codes), and research-reliable clinicians administering this specific assessment tool designed for this purpose. For example, the Mini PAS-ADD directly assesses for the presence of co-occurring anxiety, using a cutoff score indicating diagnostic status. Community providers, frequently practicing under significant time constraints, tend to assess symptoms from the context of what may respond to medication rather than closely following diagnostic criteria, particularly when treating this population. If the topics discussed in that episode of care do not closely reflect the presence of an anxiety disorder, it is unlikely further query will occur to elicit anxiety disorder criteria and subsequent assignment of the diagnostic code. In addition, it is also unclear to what degree general community providers directly assess anxiety symptoms and whether they provide a diagnostic code for this diagnosis if observed. Even within the control population, the most common anxiety diagnostic billing code identified corresponded to anxiety disorder NOS rather than a specific anxiety disorder such as generalized anxiety disorder.

Overall, the two data sources were found to be associated but with weak correlations. Diagnostic codes do not identify co-occurring anxiety in the same way that a semistructured interview might. Sterling et al. (2015) compared a revised measure of anxiety and depression in children with ASD to several existing measures of anxiety in children. Only a few significant correlations were found, with correlations ranging from .26 to .35. The authors concluded that these measures were not strongly related and the uses of all measures should be further investigated. Study researchers also felt that the revised measure correlated strongly enough that it could be used to measure co-occurring

anxiety but with certain cautions (Sterling et al., 2015). The significant association between the two data sets used for this dissertation reflects a similar concept. However, this study differs from other studies where two specific assessment methods were compared to one another, as the diagnostic codes came from community diagnoses, which tend to originate from clinician impression based on history and presentation rather than a formal measure of anxiety. The co-occurrence of ASD with or without intellectual disability further negates the use of common anxiety screeners in clinical settings, further influencing the correlation of diagnostic codes to the Mini PAS-ADD. The weak relationship between anxiety case status between Mini PAS-ADD and diagnostic billing codes indicates the need for caution when relying on diagnostic code data in isolation.

While the Mini PAS-ADD was used as the gold standard measure in this study, limitations exist with this tool as well. Lifetime case status is based on recall, which can be variable depending on the temporal proximity of symptom episode as well as the caregiver's familiarity with the participant and their history. When determining which method to use to measure co-occurring anxiety, the Mini PAS-ADD may provide more reliable information, as it has been found to be a reliable source in several research studies with a variety of populations (Prosser et al., 1998). The Mini PAS-ADD appears to be one of the best tools to measure co-occurring conditions the field has thus far. However, the diagnostic code data may provide a historical reference independent of informant memory. Further investigation of when the Mini PAS-ADD was administered and when a diagnostic code was assigned may inform the discrepancy found between these two data sources.

Validity of Diagnostic Codes

Diagnostic code data were found to be associated but weakly correlated with data from the Mini PAS-ADD. Sensitivity and specificity estimates were calculated to reflect the validity of diagnostic codes when compared to the Mini PAS-ADD. These estimates were derived from cross-tabulations where diagnostic code case status was compared to case status from the Mini PAS-ADD. The Mini PAS-ADD lifetime diagnosis of co-occurring anxiety was considered to be the true diagnostic status for participants. Sensitivity is the proportion of participants with a lifetime history of anxiety identified on the Mini PAS-ADD who had a diagnostic billing code corresponding to an anxiety disorder. Specificity is the proportion of participants without a lifetime history of anxiety based on the Mini PAS-ADD who had no diagnostic code corresponding to an anxiety disorder. Sensitivity and specificity estimates somewhat work together. An ideal test would have both high sensitivity and high specificity, meaning that the test can accurately identify both those with the disease and exclude those without the disease. This is somewhat rare. For studies similar to this one, there are no suggested values or qualifiers to determine expectations for sensitivity or specificity estimate. Statistical research papers suggest that clinical judgment is used in determining whether an estimate is acceptable. For the purpose of this study, it would be ideal to have a highly sensitive test, as that would indicate that diagnostic codes had identified a large number of participants with anxiety. While a highly specific test has benefits, as it would detect the individuals without the disorder, the purpose of this study is to identify and present the number of participants positive for a co-occurring anxiety disorder. Some statistical papers suggest that a highly specific test is good at ruling in those with the disorder, as those with a

positive test are likely to have the disorder (Akobeng, 2006). While this is a suggested use of the specificity estimate, this concept is somewhat irrelevant to this research study. Again, the larger purpose of the study was to evaluate the prevalence, or presence, of anxiety in adults with ASD using diagnostic codes.

Overall, the sensitivity estimates were inadequate in identifying participants with anxiety. The sensitivity estimate for Anxiety suggests that about 55% of the participants with anxiety were detected with diagnostic codes. This estimate is not sufficient for identification of anxiety. Of the 113 participants identified as having anxiety with the Mini PAS-ADD, only 62 of them were found to have anxiety through diagnostic codes. If diagnostic code data were solely being used to report the prevalence of anxiety, 51 participants, or 45%, would not be accounted for. More research is warranted to investigate why these participants were not identified by diagnostic code data. This has implications for both the clinical and research communities. From a research standpoint, it is important to identify why these participants were identified with diagnostic codes. Perhaps diagnostic codes are better at identifying co-occurring anxiety in a specific subsection of adults with ASD. Clinically, it would be good to identify why diagnostic codes missed almost half of the adults with ASD, as they could benefit from an intervention aimed to ameliorate symptoms of anxiety.

The specificity estimate for Anxiety was higher, indicating that diagnostic codes identified 60% of the participants without anxiety. This higher specificity estimate suggests that the diagnostic codes were better at identifying those without anxiety. With that said, a specificity estimate of 60.5 is not highly specific but specificity appears to be a strength for diagnostic codes for identifying anxiety.

The sensitivity and specificity estimates were much stronger for the variable of OCD. The sensitivity estimate for OCD was very low and the specificity estimate was very high. This indicates that diagnostic codes are very good at identifying those without OCD and not good at identifying those with OCD. For measurement and clinical purposes, it would be much more beneficial for diagnostic codes to identify those with OCD. The low sensitivity estimate for OCD could reflect the challenge providers face when attempting to identify OCD in individuals with ASD, as there is a large amount of symptom overlap.

When anxiety and OCD were collapsed into one variable, the sensitivity and specificity estimates followed a different pattern. The sensitivity estimate was higher, indicating that the diagnostic codes captured a larger proportion of the participants with anxiety. The specificity estimate was slightly lower. This suggests that when anxiety and OCD are measured together, diagnostic codes are better at capturing more participants with anxiety or OCD. It may be beneficial to consider this in the future development of anxiety measures for this population.

Diagnostic code data were found associated with but weakly correlated to data from the Mini PAS-ADD. The sensitivity estimates for all variables suggest that diagnostic code data accurately identified only half of the participants with a co-occurring anxiety disorder. This also suggests that the other half of the participants with anxiety were not identified. There are many reasons why an individual with an anxiety disorder might not have a diagnostic code in their medical record, but it is important to reiterate that the diagnostic code data missed a large proportion of the participants who were identified as having an anxiety disorder by the Mini PAS-ADD. This is a weakness of the

diagnostic code data.

The specificity estimates for Anxiety and Anxiety/OCD suggested that diagnostic code data accurately identified 50-60% of the participants without a co-occurring anxiety disorder. This estimate is higher, indicating that more of the sample was correctly identified as not having the disorder. This information continues to demonstrate the limited abilities of diagnostic code data to accurately identify individuals with or without co-occurring anxiety. Several possible reasons for this inadequacy exist. For participants who were incorrectly identified as having anxiety by the diagnostic codes, meaning they were not captured as having anxiety by the Mini PAS-ADD, it is possible that the individual providing information to the Mini PAS-ADD forgot about a previous time when the participant was exhibiting symptoms. It is also possible that the participant's total score for anxiety on the Mini PAS-ADD fell just below the cutoff, a limitation demonstrated by some low sensitivity estimates for anxiety on this measure (Janssen & Maes, 2013). It is also possible that participants exhibited signs of anxiety or received a diagnostic code for anxiety after the Mini PAS-ADD was administered. For participants who were not identified by diagnostic code data, it is possible their providing clinician was unable to assess for anxiety due to limited verbal abilities. It is also possible that their provider identified an anxiety disorder but was not directly treating the disorder, and therefore did not submit a diagnostic code for co-occurring anxiety. While the sensitivity and specificity estimates of diagnostic codes approached ranges that could be considered acceptable, they speak to the limitations of the diagnostic code data.

Sensitivity and specificity estimates are widely used for test development in both medical and psychological practices. Sensitivity and specificity are typically used to

determine how well a test is or is not measuring a concept during the test development process. Although some papers provide recommended estimates to use for measuring efficiency or acceptability of a measure, these recommendations are less applicable when evaluating sensitivity and specificity for binary variables. Overall, the research indicates that clinician judgment is the best suggestion when determining if a sensitivity or specificity estimate is appropriate. It is suggested that the clinician decide whether it is more important to correctly identify someone with the disease using sensitivity and have a lower threshold for ruling out the disease or vice versa (Akobeng, 2006). For this study, I felt that it was more important to correctly identify a participant with the disease. Given this decision, the sensitivity estimates were quite insufficient, only correctly identifying half the participants with anxiety. The other half of participants identified as having anxiety with the Mini PAS-ADD were not identified with diagnostic billing codes. Because billing codes reflect clinical assessment and treatment, this suggests that in a substantial minority of adults with ASD, anxiety is present but unrecognized and untreated. When we consider using diagnostic codes for the identification of participants with anxiety, it should be advised that these data are missing a significant number of individuals with the disorder and underestimating the actual prevalence.

Strengths and Weaknesses of Diagnostic Codes

Positive predictive values and negative predictive values were calculated and provide insight into the strengths and weaknesses of diagnostic codes when compared to the Mini PAS-ADD. The positive predictive value is the probability that a participant with a positive test result is actually positive with the concept being measured. The

negative predictive value is the probability that a participant with a negative test result is actually absent of the concept being measured. In the case of this dissertation, the positive predictive value is the probability that a participant with a diagnostic code case status positive for anxiety actually has anxiety. The negative predictive value is the probability that a participant with a diagnostic code case status negative for anxiety is actually without anxiety. These values describe the probability of actually having or not having anxiety as determined by the diagnostic code case status. These values are discussed based on the different variables and reflect potential strengths for measurement of anxiety in this population using diagnostic codes.

When diagnostic codes were used to measure Anxiety, the probabilities of a test result being correct were fairly low. The probability that a participant with a positive test for anxiety was correct was only 66%, meaning 1/3 of the participants potentially had an inaccurate test result. The probability that a participant with a negative test for anxiety was correctly identified as being absent of co-occurring anxiety was only 49%. These numbers suggest poor probability that a diagnostic case status is correct.

The positive and negative predictive values for OCD were slightly more acceptable with a positive predictive value of 62.5% and negative predictive value of 70.5%. Similar to the sensitivity and specificity estimates for OCD, the diagnostic codes appear to be more accurate in identifying those without the disorder. The negative predictive value for OCD suggests that the probability of being absent of OCD is 70%, which is fairly high.

The positive and negative predictive values changed significantly when Anxiety and OCD were collapsed into Anxiety/OCD. These changes were also similar to the

changes in the sensitivity and specificity estimates. The positive predictive value suggests that the probability of actually having anxiety with a positive case status for anxiety is 73%. The negative predictive value was much lower at 39.8%, suggesting only a 40% chance of not having anxiety given a negative case status for anxiety. When the concepts were collapsed, the probability of actually having anxiety based on a diagnostic code increased.

The positive and negative predictive values describe the probability of actually having a correct case status from diagnostic billing codes. These values suggest that the probability of the diagnostic codes being correct is fairly low for the majority of the factors, with the exceptions of being case status negative for OCD and case status positive for Anxiety/OCD. When considering whether or not diagnostic codes are an acceptable measure of anxiety in adults with ASD, the probability of a case status being correct is low and suggests that diagnostic codes are an unpredictable measure of anxiety in this population.

Uses of Diagnostic Billing Codes

The larger aim of this dissertation was to evaluate the use of diagnostic codes to measure anxiety in adults with ASD. While the diagnostic codes were significantly associated and correlated with Mini PAS-ADD measurements of anxiety, the correlations were low. The sensitivity, specificity, positive predictive values, and negative values were all relatively low as well. These analyses indicate that diagnostic codes are not good at capturing those with or without anxiety and the probability of a case status being accurate is low. More research is warranted to determine why these values were low. For

this dissertation, it was decided that while the reliability and validity indicators were low, it was still acceptable to use diagnostic codes to present the prevalence of co-occurring anxiety in this population. That decision was made based on three factors: there were significant associations between diagnostic codes and the Mini PAS-ADD; there were significant correlations found between the data; and the prevalence estimates were relative similar when compared visually. Diagnostic codes were used to present the prevalence of co-occurring anxiety in adults with ASD and the control cohort, with the understanding that this is purely an estimate of co-occurring anxiety in this population. Data from the Mini PAS-ADD were prioritized and used first when possible.

One larger concept to discuss is the one of measurement. The diagnostic codes were not sensitive, specific, or well correlated with the Mini PAS-ADD. This indicates and reflects a larger measurement issue occurring in this area of research. One issue is that while the Mini PAS-ADD is suggested to be a reliable and accepted assessment tool to evaluate co-occurring psychiatric conditions, the sensitivity rates were found to vary from 40% to 80% (Janssen & Maes, 2013). Another study found the sensitivity to be 100% (Devine, Taggart, & McLorian, 2009). The specificity of the Mini PAS-ADD ranged from 71% to 100% (Devine, Taggart, & McLorian, 2009; Janssen & Maes, 2013). This suggests that this measure also varies in the ability to measure co-occurring psychiatric disorders in this population. The diagnostic codes reflect community provider practices surrounding the diagnosis, and likely treatment of anxiety. The Mini PAS-ADD measures current and lifetime anxiety based on caregiver's observations and recall of anxiety diagnostic criteria. The difference in the end result of anxiety case status between these two sources is apparent, as is the need in the field for more sensitive, specific, and

reliable methods of measuring anxiety in individuals with ASD in the community setting.

There is some existing literature that discusses the use of diagnostic codes to investigate the prevalence and speaks to various measurement considerations. These studies are not focused on ASD but provide insight into how diagnostic codes were found to be beneficial or show limitations in other areas. Denny (2012) speaks to issues of collecting data from electronic health records. This author discusses several studies with findings similar to the results described in this dissertation, with diagnostic codes having poor sensitivity and specificity. However, this chapter by Denny (2012) also addresses the findings from several studies that indicate higher sensitivity and lower specificity of diagnostic codes. There are suggestions that billing codes providing information on procedures were more specific than diagnostic codes providing information on diagnoses. The consensus from this review of the literature was that diagnostic codes could be used to present findings but might be better used as a screening method (Denny, 2012). The findings in this dissertation are similar in that the diagnostic codes appear to be measuring something similar to the Mini PAS-ADD and might serve as a good screening method to then do further assessment of co-occurring anxiety.

Several other studies presented findings comparing diagnostic codes to standardized measures. Wang, Laud, Macias, and Nattinger (2010) compared ICD-9 codes to operative notes from spinal surgeries. These authors found that ICD-9 codes had low sensitivity and high specificity with more specific diagnoses, much like the OCD diagnostic code sensitivity and specificity estimates found in this dissertation (Wang et al., 2010). When (Campbell et al., 2011) evaluated diagnostic codes compared to an in-person interview of surgical procedures, they found that diagnostic codes under-

represented prevalence. This was displayed in this dissertation. When co-occurring anxiety was independently used to present prevalence, the rates were much lower. Croen et al. (2015) were the first to use diagnostic codes to present prevalence on co-occurring psychiatric conditions. Kohane et al. (2011) used diagnostic codes to investigate comorbidity burden in children and young adults with ASD. Their study focused on epilepsy, schizophrenia, inflammatory bowel disease, bowel disorders, sleep disorders, muscular dystrophy, diabetes mellitus, cranial anomalies, and autoimmune disorders. The authors commented on the use of diagnostic codes to report the prevalence of these disorders. They mentioned a problem with inclusion criteria for participants with ASD, as many of the participants visited several hospitals queried and the participants may have been counted twice. Prevalence of disorders found in the ASD population study was similar but discrepant from prevalence rates found in other studies (Kohane et al., 2011). Similar discrepancies were observed in this dissertation as well. Lastly, Kohane et al. (2011) suggested using diagnostic codes to first identify participants at-risk and then potentially using natural language processing to pull information from electronically stored clinical notes (Kohane et al., 2011).

The existing literature is consistent in that all discussions suggest further research in this area to strengthen our understanding of how or when to use diagnostic codes to investigate prevalence. In addition to implications for further research, there are some clinical implications for the use of diagnostic codes. While it would be beneficial to measure the rates of anxiety in this population, clinically, it is important to identify these individuals. Specifically, when sensitivity is considered, it would be preferable that diagnostic codes were detecting more participants with anxiety in this population. This

would suggest that individuals with anxiety would be identified and subsequently treated for anxiety. Given the symptom overlap between anxiety and ASD, as well as large numbers of anxiety symptoms in this population, a false positive, or subthreshold level for meeting diagnostic criteria, may not be detrimental in this scenario. Limited communication abilities and problem behaviors could be impacting the sensitivity of this test. Interestingly, participants with severe intellectual and/or communication deficits represented a higher than expected proportion of those with anxiety, which is important information for providers to consider when conducting assessments.

Co-occurring Anxiety in Adults With ASD

There are several factors to discuss regarding co-occurring anxiety in adults with ASD. First, it is important to compare the rates of anxiety found in this study to rates found in other studies, particularly comparing the rates to the only other study that used diagnostic billing codes to report the prevalence of co-occurring anxiety. Second, it is important to note the types of anxiety disorder diagnoses found and the lack of specificity in these diagnoses. Third, the rates of anxiety differed depending on how anxiety was measured, either with an in-person semistructured interview or through diagnostic code data. While diagnostic code data were found to have low sensitivity and specificity and were weakly correlated to the Mini PAS-ADD, these data were included in anxiety case status determination as it provided a larger sample size from which to compare findings from this dissertation to those prevalence rates reported in other research studies.

Some studies have investigated the prevalence of co-occurring anxiety in adults with ASD. The percentages of participants with co-occurring anxiety ranged from 21-70.

Gillberg, Helles, Bilstedt, and Gillberg (2016) 2016 found that out of 50 adults with Asperger syndrome, only three had never met criteria for an anxiety disorder (Gillberg et al., 2016). Lever and Geurts (2016) found that in a large sample of adults with intellectual quotients greater than 80, only 18.3% of participants met criteria for anxiety from a symptom checklist. This estimate was much lower than the proportion of participants in this dissertation. Charlot et al. (2008) identified a similar proportion of 62% of adults receiving inpatient services met criteria for anxiety. Lugnegard, Hallerback, and Gillberg (2011) reported that 50% of the sample presented with co-occurring anxiety disorders. Mazefsky, Folstein, and Lainhart (2008) reported 59% and 41% of their sample to have a co-occurring anxiety disorder. Hofvander et al. (2009) also reported that anxiety disorders were the most common found in a study of adults with normal cognitive ability. These prevalence rates of anxiety are found in Figure 1. Some of these studies displayed similar prevalence rates in adults with ASD; however, all of these studies varied in sample size, population, and measurement tools used to evaluate for co-occurring anxiety. Interestingly, many studies of anxiety in adults with ASD consider the lifetime, rather than the current anxiety symptoms.

For this dissertation study, the percentage of participants with co-occurring anxiety and anxiety/OCD was 58.2% and 67.3% with the Mini PAS-ADD and 46.6% and 50.0% with diagnostic codes, respectively. When the Mini PAS-ADD was used to present the prevalence of anxiety, it was the third highest rate of anxiety when compared to other studies. The diagnostic code data yielded lower rates of anxiety, Anxiety, 46.4%, which was more consistent with other studies, where estimates were found to be 50% (Hofvander et al., 2009) and 53% (Buck et al., 2014). When informally compared, the

diagnostic code data appeared to be slightly more conservative but provided a similar estimate of co-occurring anxiety in this population. The sample size used for this study was much larger than those of previous studies, which could indicate that these studies are not capturing a large portion of adults with ASD who also have co-occurring anxiety. Overall, this study revealed a similar prevalence rate to a number of other studies.

There is only one other study to date that has used diagnosed codes to present the prevalence of co-occurring psychiatric conditions (Croen et al., 2015). Croen et al. (2015) presented data on the prevalence of a variety of co-occurring psychiatric and medical comorbidities in a sample of over 1000 participants. This study reported that 29% of their population presented with a co-occurring anxiety disorder. This is far less than the proportion found in the current study, as well as the proportions presented in other samples and studies. The sample size in the Croen et al. (2015) study was much larger, but case status of ASD was determined differently. Croen et al. (2015) identified participants with ASD based on diagnostic codes for those disorders. Two diagnostic codes for ASD were required for inclusion in the study (Croen et al., 2015). This is very different from the current study, which used more comprehensive methods of identifying participants identifying participants with ASD and based ASD case status on in-person assessments. Another difference between this dissertation and the study by Croen et al. (2015) was that Croen et al. (2015) used slightly different and fewer diagnostic codes to identify anxiety. In fact, Croen et al. (2015) only used seven diagnostic codes, while this dissertation study used 13. Both of these factors return to a larger issue of measurement variations, as both participant inclusion criteria and method of measuring co-occurring anxiety differed. The current dissertation project suggested a much higher prevalence rate

of co-occurring anxiety, 46.4-58.2%, than the 29% presented in the study by Croen et al. (2015).

The overall prevalence of co-occurring anxiety was presented through an indicator variable that incorporated all diagnostic codes for anxiety. Frequencies and proportions for specific diagnostic codes were also presented. The most common diagnostic code was anxiety state, unspecified (n = 179, 43.4%), followed by generalized anxiety disorder (n = 69, 19.2%) and social phobia (n = 11, 3.1%). All other diagnostic codes had frequencies of 10 or less. This happened to be the case for the control cohort as well, indicating that healthcare providers are not utilizing specific diagnostic codes in medical records. The diagnostic code data lacked the distinction among specific anxiety disorders. The Mini PAS-ADD also lacks diagnostic indication for specific anxiety disorders, as was used in other studies that focused on specific anxiety disorders like social anxiety (Maddox & White, 2015; Swain et al., 2015). Due to insufficient data from both data sources, I was unable to comment further on the presentation of anxiety diagnoses found in this population.

Lastly, the prevalence of co-occurring anxiety was presented using both Mini PAS-ADD and diagnostic code data. These data sources were combined to present the prevalence of co-occurring anxiety when either measure was used. The proportions of anxiety differed significantly depending on which measurement tool was used. The proportion of all anxiety variables was the largest when the Mini PAS-ADD was used to identify co-occurring anxiety. In fact, the proportion of the overall anxiety variables was 12 to 17 percentage points lower when diagnostic code data were used to investigate prevalence. Lastly, when the data were combined, the proportions of co-occurring were

most similar to estimates from the Mini PAS-ADD.

Prevalence of Anxiety - Comparison Between Adults With ASD and Controls

The prevalence of co-occurring anxiety in adults with ASD was compared to anxiety in same age-and sex-matched controls. Significant associations were found for each variable, and the proportion of anxiety was higher in adults with anxiety than in controls. Previous research comparing prevalence rates of co-occurring anxiety between typically developing controls to adults with ASD have found similar findings (Croen et al., 2015; Hare et al., 2015; Swain et al., 2015). Overlapping symptomatology between anxiety and ASD could be responsible for higher prevalence rates of co-occurring anxiety in adults with ASD; however, the majority of the literature is currently suggesting that the prevalence rate goes beyond the presence of symptoms and suggests that more individuals with ASD also meet criteria for a full anxiety disorder compared to typically developing peers (Kerns & Kendall, 2013; Kerns et al., 2014).

The ASD cohort demonstrates a higher rate of anxiety disorders overall and among individual diagnoses than in the control cohort. Given the symptom overlap between anxiety and ASD, as well as the expressive language impairment frequently experienced in adults with ASD, one might think that providers would be more inclined to give an adult with ASD an unspecified diagnosis rather than an adult without ASD. However, the control cohort also had a paucity of specific diagnostic codes corresponding to an anxiety disorder beyond unspecified anxiety state. This suggests that providers do not routinely differentiate among anxiety disorder type in either population.

Technically, the use of the unspecified anxiety disorder diagnosis was intended to capture those with an anxiety disorder that did not meet criteria for a more specific diagnosis (American Psychological Association, 2013; Medicode, 1996). The similarities in use of this diagnosis between cohorts suggest that time constraints may limit the query of more specific anxiety criteria or conducting further assessment of these anxiety symptom clusters.

Prevalence of Anxiety - Comparison to National Prevalence

The prevalence of co-occurring anxiety in adults with ASD and anxiety in a control cohort was compared to national prevalence rates. The national prevalence rates used for comparison were derived from a well-validated and widely accepted study that used a semistructured interview to evaluate prevalence rates in a very large sample of participants in the United States (Kessler et al., 2012). Kessler et al. (2012) presented prevalence findings on an all-encompassing variable of anxiety, including OCD, and some individual diagnoses. The national prevalence study report of higher specific anxiety disorder estimates likely reflected the direct ascertainment and use of a semistructured interview to obtain this information with the subsequent collection of detailed information needed to establish specific anxiety disorder diagnoses (Kessler et al., 2012). Thus, the comparison between this study's findings from diagnostic billing code data with those of the national prevalence study lacks value for specific anxiety disorders because the majority of diagnostic billing codes in this study were for an unspecified anxiety disorder. Considering the overall prevalence of anxiety, adults with

ASD showed higher rates than found in the control cohort and reported in the national prevalence study, while the control cohort demonstrated lower anxiety rates than those reported in the national prevalence (Kessler et al., 2012). This difference between the control cohort and national prevalence study likely reflect the inherent disparity in identifying comorbid anxiety when using passive versus active participation study methodologies. The increased prevalence of co-occurring anxiety among adults with ASD, when compared to controls, suggests higher anxiety experienced by those with ASD. However, this finding may also be attributed to increased interaction with health care services, subsequently increasing the likelihood of receiving any anxiety diagnosis. Also, low sensitivity estimates found for diagnostic code data, in light of national prevalence study findings, suggest that using diagnostic codes exclusively may cause a large number of control participants who actually have anxiety to be missed. The findings from diagnostic code data should be considered with caution given the low sensitivity estimates of diagnostic billing codes.

Prevalence of Anxiety – Comparison Between Sexes

Existing research indicates that more females than males display certain anxiety disorders, such as specific phobias, panic disorder, or agoraphobia (American Psychological Association, 2013). Some prevalence estimates suggest that more males than females experience social anxiety disorder (American Psychological Association, 2013). An exploratory analysis was conducted to evaluate potential sex differences in prevalence findings of anxiety in both the ASD cohort and control cohort. This analysis was performed with diagnostic code data, rather than data from the Mini PAS-ADD, so

that data for both cohorts had a single source type of ascertainment.

When the prevalence of co-occurring anxiety was compared between males and females in the ASD cohort, significant associations were found for all anxiety groups (i.e., Anxiety, OCD, Anxiety/OCD), with a higher proportion of females affected than males. In the control cohort, the only significant association with sex was for the combined Anxiety/OCD category, with a larger proportion of females affected. The higher proportion of anxiety found in females in the control cohort is consistent with the majority of current research findings (Kessler et al., 2013). However, the proportion of females in the control cohort was substantially lower than the proportion ascertained for Kessler et al. (2015).

The higher rate of anxiety among in females with ASD has some clinical implications. It indicates a stronger need for providers to screen for anxiety in females with ASD. In addition, females with ASD tend to be more significantly impaired, including having more limited communication abilities (Frazier, Georgiades, Bishop, & Hardan, 2014; Rubenstein, Wiggins, & Lee, 2015). This reduced capacity to express internal experiences of anxiety merits a proactive approach by providers to query these symptoms in women with ASD.

Co-occurring Anxiety and Intellectual or Adaptive Behavior

The presence of co-occurring anxiety was compared to intellectual functioning and adaptive behavior in the larger ASD cohort. These data were compared using chi-square associations and descriptive analyses. Logistic regression analyses were conducted to predict case status for anxiety given the various levels of intellectual functioning or

adaptive behavior. Both Mini PAS-ADD data and diagnostic code data were used to account for anxiety in this cohort. Significant associations were found for comparisons between intellectual functioning and Anxiety and Anxiety/OCD, but not OCD only. Significant associations were found for all anxiety variables and categories of adaptive behavior. Descriptive and demographic results are discussed, as well as significant findings in proportions of anxiety in the various categories and regression results.

Anxiety and Intellectual Functioning

The intellectual functioning demographics are worth discussing. Intellectual functioning abilities were broken out into three categories denoting normal IQ (FSIQ >70), mild ID (FSIQ = 50-69), and severe ID and untestable (FSIQ <50). Participants who fell into the category of untestable typically had significant behavior difficulties, which resulted in the inability to test, or additional disabilities that invalidated measurement tools. Many of these participants were determined to have severely impacted cognitive abilities, as determined through various other measures. For participants where this could be determined, they were included in the severe ID category.

Overall, those with ASD and anxiety were disproportionately affected by severe intellectual disability and adaptive behavior across the categories of anxiety. The majority of the data in these analyses resulted from the Mini PAS-ADD, which was designed for use with individuals with varying degrees of intellectual disability. These findings indicate the presence of severe intellectual disability increases, rather than reduces, the risk for co-occurring anxiety among adults with ASD. This has serious clinical

implications, as many providers do not assess for co-occurring anxiety disorders in their clients with ASD and severe ID. Despite limited expressive language, adults with ASD and severe ID may still communicate their anxiety through certain behavior patterns that originate from feelings of fear or worry. The research on adults with ASD and severe ID who also experience co-occurring anxiety is sparse as most studies of co-occurring anxiety in adults with ASD exclude participants with intellectual quotients below 70.

Anxiety and Adaptive Behavior

Adaptive behavior abilities were collapsed into similar categories as intellectual functioning. The VABS and VABS-II provide a good assessment of adaptive behavior and capture the abilities of the adults with ASD; however, the majority of participants obtained scores below 70 (n = 215). This represents a larger proportion than those participants with an intellectual ability score below 70 (n = 89) and demonstrates the substantial impairment ASD characteristics have on functional levels. Although measures of intellectual functioning provide descriptive categories for scores below 70, many adaptive behavior tests do not. In order to investigate more differences between participants based on adaptive behavior, I grouped the participants into three levels of adaptive behavior, similarly to those of intellectual functioning. While there was a better distribution across groups, a significant number of participants received scores below 50, indicating overall poor adaptive behavior in the sample overall.

Significant associations were found for nearly all anxiety variables and categories of adaptive behavior, except for OCD and the Daily Living scale. The most significant finding when areas of adaptive behavior were compared to anxiety variables was that

more participants with severely limited adaptive abilities had anxiety. Regression analyses suggested that severely limited adaptive behavior abilities predicted anxiety. Similar to intellectual functioning, participants with severe Adaptive Behavior Composite, Communication, or Social scores were 1.3-3.6 times more likely to have anxiety. This was not the case for the Daily Living scale; no functional group within the Daily Living scale predicted anxiety or OCD. Implications of these findings mirror those of intellectual functioning and anxiety. Participants with significantly limited adaptive behavior abilities were more likely to experience anxiety. Further investigation is merited to explore whether limited adaptive abilities predispose an individual to anxiety and the degree to which, if at all, anxiety interferes with the development of adaptive behavior abilities. Impaired communication and social skills may make life more anxiety provoking. Alternatively, anxiety symptoms may make it more difficult for individuals to carry out everyday interactions and to develop communication abilities. More research is warranted on this topic, as results could have implications for the development of interventions aimed at reducing anxiety or improving communication or social abilities.

Co-occurring Anxiety and Employment

The final aim of this dissertation was to evaluate the association between co-occurring anxiety and employment. The presence of anxiety was compared to employment status and use of vocational rehabilitation. The current literature on adults with ASD shows that many adults with ASD have poor employment outcomes (Roux et al., 2015; Roux et al., 2013; Wei et al., 2015). This phenomenon is even true for adults with ASD who have normal intellectual abilities, as they are found unable to be gainfully

employed (Gotham, Brunwasser, & Lord, 2015). The literature on individuals with mental health disorders, who are absent of ASD, suggests that these disorders can impact one's ability to obtain meaningful education and employment outcomes (Mojtabai et al., 2015a; Mojtabai et al., 2015b). These studies indicated that typically developing individuals with anxiety had lower odds of attending college and being employed (Mojtabai et al., 2015a). Murphy et al. (2009) also reported that having OCD was associated with impairments socially, personally, and vocationally. Several researchers who have reported findings on adults with ASD hypothesized that adults with ASD could be impacted further in their ability to gain employment if they also had co-occurring anxiety (Farley et al., 2009; Henninger & Taylor, 2013). This concept was explored in this dissertation through associations between anxiety and employment factors and regression analyses.

Significant associations were found between employment status and all anxiety variables, indicating that employment status was inversely associated with the presence of an anxiety disorder. The most apparent differences in the data were found between those unemployed with anxiety, as more participants with anxiety were unemployed. Another interesting finding was that a large number of participants with supported employment experienced anxiety as well. Participants without anxiety were more likely to be independently employed. Regression analyses demonstrated that Anxiety, OCD, and Anxiety/OCD were significantly associated with supported employment. OCD significantly predicted supported employment. These findings support the hypothesis that anxiety may negatively impact one's ability attain independent employment. No existing literature addresses this concept in the context of ASD; this hypothesis merits further

exploration. It would be interesting to investigate further the factors linking anxiety and employment status in adults with ASD.

Study Limitations

This dissertation provides several contributions to the current literature base but is not without its limitations. The sample size, particularly the size of the sample used for the comparisons of in-person records to diagnostic codes, was limited. The sample was also skewed towards certain demographics. Next, the Mini PAS-ADD used to assess for the presence of co-occurring anxiety had its limitation. The sample used for comparison of in-person records to diagnostic billing code records was smaller than desired, which impacted the power of statistical analyses. Lastly, there are some limitations in how these data and analyses can be interpreted.

This study was limited by sample size and demographics. While there were a substantial number of participants in the full ASD cohort, only half of those participants had both in-person records and diagnostic codes available for comparison. This significantly impacts the power of the analysis. The sample was also limited by demographics. Given that a large number of participants were ascertained in the 1980s, the sample was somewhat limited to an outdated concept of autism spectrum disorder. However, the inclusion of participants more recently ascertained and those reclassified as having ASD from the original 1980s cohort allowed for a representative sample of adults less severely impacted by ASD, suggested by the presence of normal intellectual functioning in 61% of the ASD cohort. Lastly, sample demographics were very specific to the region of Utah, and subsequently lacked an ethnic diversity representative of the

US population. Studying psychiatric comorbidity among participants from rural areas is also problematic to the degree limited access to healthcare services is reflected in comorbidity presence.

The study was also limited in the tools used for measurement and analyses. Although the Mini PAS-ADD has been studied reliably for the measurement of co-occurring psychiatric conditions in adults with developmental disabilities, some studies report limited sensitivity and specificity when compared to trained clinician assessments (Prosser et al., 1998). This instrument provided this study's gold standard for psychiatric comorbidity in several of the main analyses, in particular for the validation of diagnostic billing code use.

Lastly, diagnostic code data were used in this study for a variety of purposes. Diagnostic codes, as displayed in this study, are limited in their measurement properties and subject to clinician and organization bias. Diagnostic codes are primarily populated for billing purposes rather than directing clinical care. It is possible that clinicians are treating individuals for anxiety but implementing another billing code or none at all, leading to the absence of diagnostic code for anxiety when an individual truly has anxiety. Our sensitivity findings for this diagnostic billing codes supports this conclusion: the absence of diagnostic code for anxiety acts as a poor predictor in whether anxiety has been considered and/or ruled out as a diagnosis.

Implications for Future Research

The current study has many implications for further research. Further analysis of this data set is warranted, particularly as it pertains to how a participant is given a case

status of anxiety. This research study could be expanded in sample size and to other psychiatric conditions. Diagnostic codes should be compared to different measures of psychiatric conditions and the measurement implications should be further evaluated. Lastly, the associations found between anxiety and intellectual functioning, adaptive behavior, and employment status prompt further investigation into the cause and effect nature of these relationships and subsequently, implications for anxiety treatment and adaptive skill development.

This dissertation had a focused scope and the data were organized and cleaned solely for the study purposes. It would be interesting to consider or redefine inclusion criteria for a case status positive for anxiety. One might consider that case status for anxiety would be identified with two diagnostic codes in the record. It is possible that specificity could improve with this change. It would also be interesting to count the number of anxiety diagnoses one has on their medical record.

Next, this project could be expanded to include other facets of functioning and increased sample size. The project could expand to include other psychiatric conditions in addition to anxiety. Investigators also have data on parent report of co-occurring psychiatric conditions, which other studies have found to correlate with the Mini PAS-ADD, with the exception of co-occurring anxiety. It would be interesting to evaluate the association and correlation of diagnostic codes to parent report of co-occurring psychiatric conditions. These comparisons would also benefit from an increase in sample size.

The Mini PAS-ADD was used in this study, as it is accepted as a reliable measure of co-occurring psychiatric conditions in individuals with an intellectual disability;

however, it has several limitations. Future research should include measures of better sensitivity and specificity. Additional measures of psychiatric conditions should also be included in the comparison to diagnostic codes.

Lastly, adults with ASD and severely limited intellectual functioning and adaptive behavior were more likely to experience anxiety. These analyses primarily used Mini PAS-ADD case status; however, repeating these analyses with anxiety case status defined by diagnostic codes instead could reflect the amount to which providers in the community are identifying anxiety in individuals with ASD and severely limited intellectual functioning and adaptive behavior. This could also shed light on potential reasons diagnostic code data did not identify participants who actually have anxiety.

Practical Implications

Results from this dissertation provided implications for the autism research community and community providers serving adults with ASD. Adults with ASD receive services from a variety of clinicians (e.g., school psychologists, clinical psychologists, psychiatrists, social workers, speech and language pathologists, and special education teachers). Many of these providers informally acknowledge that individuals with ASD experience and demonstrate many anxiety symptoms, but the high overlap of symptoms between ASD and anxiety and frequent lack of communication abilities make it difficult for clinicians to consistently identify anxiety in this population. This study provides information about the difficulty providers have in identifying co-occurring anxiety. The results provide an estimate of how many individuals with ASD might be experiencing co-occurring anxiety and potential differences in prevalence rates between males and

females. The results suggested that a large number of individuals who have limited intellectual and communication abilities also experience anxiety. In addition, the association between co-occurring anxiety and employment suggests that adults with ASD who have anxiety are more likely to be unemployed or require supported employment positions. This finding may suggest the need to consider co-occurring anxiety as a common obstacle faced by adults with ASD who struggle to maintain independent employment, potentially among those adults who otherwise have normal intellectual functioning.

This dissertation provides insight into the difficulty researchers and clinicians have in identifying co-occurring anxiety in adults with ASD. The measurement challenges in this study and those reflected in the research demonstrate how difficult it can be for a clinician to determine whether an individual has anxiety. Unclear diagnoses or symptoms make it difficult to recommend appropriate interventions. This puts forth the importance that both the research and clinical fields may want to invest efforts into creating validated measures of anxiety in this population that could be implemented successfully in both research and clinical settings. Kerns, Renno, Kendall, Wood, and Storch (2016) have been pursuing projects that adapt an already validated assessment of anxiety, the Anxiety Disorders Interview Schedule, for individuals with ASD. Ozsivadjian, Hibberd, and Hollocks (2014) have done similar work to validate the use of current screeners and assessment measures in this population. Determining who has co-occurring anxiety is vital for treatment planning and understanding the potential function of behaviors.

The estimates of co-occurring anxiety in adults with ASD contributed by this

study provide clinicians with further information of the proportion of their clients who may have co-occurring anxiety. While the estimates provided by this study are just that, estimates, this information suggests that clinicians may want to consider that a large proportion of their client base may be experiencing co-occurring anxiety. In addition, this study suggested that females with ASD may be experiencing higher rates of co-occurring anxiety than their male counterparts.

One aim of this dissertation was to investigate the association of co-occurring anxiety and intellectual or adaptive behavior abilities. Results suggested that a large proportion of participants with anxiety also had severely limited intellectual functioning or adaptive behavior. These individuals typically have difficulty expressing their experiences, particularly in regards to complex topics such as emotional experiences. Given the high rate of anxiety in this population of adults with ASD, it is important for clinicians to consider how a client's behavior or symptom presentation may relate to co-occurring anxiety rather than other forms of emotional distress. For example, if an individual is displaying disruptive behaviors, such as agitation or aggression, it is important for the clinician to consider that these behaviors could be driven by anxiety rather than conceptualizing the disruptive behavior as a direct target for pharmaceutical or behavioral intervention. If the individual receives intervention for anxiety, behaviors precipitated by the individual's experience of anxiety can recede with the use of interventions specific to anxiety and less problematic in regards to long-term health and tolerability. Identifying co-occurring anxiety in these individuals is important as is a focus on how to treat co-occurring anxiety in this population, particularly for those with more intellectual and adaptive impairment. Currently, the majority of psychosocial

interventions for individuals with ASD and co-occurring anxiety consist of therapy requiring high levels of communication skills (Wood et al., 2015).

Lastly, when the presence of co-occurring anxiety was compared to employment status, participants with anxiety were more likely to be unemployed or in supported employment than participants without co-occurring anxiety. Alternatively, participants without anxiety were more likely to be independently employed. The sample sizes for this comparison were relatively small, so further investigation of this concept is needed. However, given the literature suggesting that co-occurring anxiety in the general population impacts one's ability to work, it is not surprising that this phenomenon extends to those with ASD. When providers are aiding clients with ASD in their efforts to become employed, it could be beneficial to consider the impact co-occurring anxiety could have on these outcomes and subsequently implemented strategies to address anxiety when present.

Overall, the clinical implications of this dissertation help to confirm clinical hypotheses that individuals with ASD experience higher than expected rates of anxiety. This insight could guide treatment planning. Furthermore, participants experiencing co-occurring anxiety also experienced severely impaired intellectual and adaptive behavior functioning. These participants also tended to be female. Finally, an interaction was found between the presence of anxiety and employment. All of these factors provide clinicians with guidelines for clinical practice with adults with ASD.

Conclusions

The overall aim of this dissertation was to improve our understanding of co-occurring anxiety in adults with ASD, both through measuring the prevalence of the disorder within a large cohort using complementary methods and evaluating consistency among results between these methods. Specifically, this study aimed to evaluate the use of diagnostic codes to present the prevalence of co-occurring anxiety. Then, the aim was to present the prevalence of co-occurring anxiety in adults with ASD using a substantially larger sample than used previously, as well as to compare these prevalence rates to a control cohort. Diagnostic code data were found to have significant limitations when evaluating anxiety prevalence, which reflects several larger measurement issues and clinical implications. The prevalence of anxiety was presented and found to affect almost half of the participants with ASD, a much larger proportion than the control cohort. Lastly, co-occurring anxiety was associated with employment status, potentially suggesting an avenue for further research or focus of intervention.

In this study, diagnostic codes were found to have several limitations when compared to an in-person assessment of co-occurring psychiatric conditions. Diagnostic codes were found to have both low sensitivity and specificity, indicating that this measurement tool is limited in its ability to accurately identify anxiety among adults with ASD. This finding was important but also limited because diagnostic codes were compared to the Mini PAS-ADD, which had its own reliability and validity limitations such as low sensitivity and specificity (Janssen & Maes, 2013). Visual analysis showed that both measures appeared to be measuring anxiety somewhat similarly, but more in-depth analyses suggest that they were likely measuring different properties of anxiety.

Neither measurement tool was really effective in measuring co-occurring anxiety in this population. It speaks to the need for further measurement development.

Anxiety was found to affect over half of the population of adults with ASD in this study. This has immense implications for providers and researchers in the field. Few published studies have presented findings in a sample of this size. This study was able to reflect on a large number of adults with ASD who also experience anxiety. In addition, a large proportion of the participants in this study had significantly limited cognitive and/or communication abilities. A large proportion of participants with these limited abilities were found to have anxiety, indicating the further need to screen for, monitor, and investigate anxiety in adults with autism. Lastly, anxiety was found to be associated with factors of employment. Previous research has implied that adults with anxiety could have worsened outcomes of education or employment. This phenomenon is seen in adults with ASD, as many studies suggest that these individuals have poor outcomes. The current study reflects a potential additional factor implicating adult outcomes, which should be researched further.

In conclusion, this study had several limitations but also provided a wealth of information for the field of psychology and ASD research. In particular, this study helps provide a comparison study to the only other large-scale study using diagnostic codes to measure co-occurring psychiatric conditions. The current study provides a reference point for which one could compare this previous study. The limitations of this study reflected larger measurement and sample restrictions. The measurement issues have implications for both clinical purposes and future research. Overall, it appears that adults with ASD

are frequently impacted by a co-occurring anxiety. This should be considered in future research studies and clinical practice.

REFERENCES

Akobeng, A. K. (2006). Understanding diagnostic tests 1: Sensitivity, specificity and predictive values. *Acta Paediatrica, 96*(3), 338-341. doi:10.1111/j.1651-2227.2006.00180.x

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: American Psychiatric Association.

American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed. rev.). Washington, DC: American Psychiatric Association.

American Psychological Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Association.

Atherton, J. (2011). Development of electronic health record. *Virtual Mentor - American Medical Association Journal of Ethics, 13*(3), 186-189.

Bailey A., Le Couteur, A., Gottesman, I., Bolton, P., Simonoff, E., Yuzda, E., & Rutter, M. (1995). Autism as a strongly genetic disorder: Evidence from a British twin study. *Psychological Medicine, 25*, 63-77.

Baker, J. P. (2013). Autism at 70 – redrawing the boundaries. *New England Journal of Medicine, 369*(12), 1089-1091. doi: 10.1056/NEJMp1306380

Bakian A.V, Bilder, D. A., Coon, H., & McMahon, W. M. (2015) Spatial relative risk patterns for autism spectrum disorders and their association with socioeconomic class indicators in Utah. *Journal of Autism and Developmental Disorders, 45*(4), 988-1000.

Bakken, T. L., Helverschou, S. B., Eilertsen, D. E., Heggelund, T., Myrbakk, E., & Martinsen, H. (2010). Psychiatric disorders in adolescents and adults with autism and intellectual disability: A representative study in one county in Norway. *Research in Developmental Disabilities, 31,* 1669-1677. doi:10.1016/j.ridd.2010.04.009

Baldwin, S., Costley, D., & Warren, A. (2014). Employment activities and experiences of adults with high-functioning autism and Asperger's disorder. *Journal of Autism and Developmental Disorders, 44*(3), 2440-2449. doi: 10.1007/s10803-104-2112

Bandelow, B., Lichte, T., Rudolf, S., Wiltink, J., & Beutel, M. E. (2014). The diagnosis of and treatment recommendations for anxiety disorders. *Deutsches Arzteblatt International, 111,* 473-480. doi: 10.3238/arztebl.2014.0473

Barneveld, P. S., Swaab, H., Fagel, S., van Engeland, H., & de Sonneville, L. M. J. (2014). Quality of life: A case-controlled long-term follow-up study, comparing young high-functioning adults with autism spectrum disorders with adults with other psychiatric disorders diagnosed in childhood. *Comprehensive Psychiatry, 55*, 302-310. http://dx.doi.org/10.1016/j.comppsych.2013.08.001

Barrera, T. L., & Norton, P. J., (2009). Quality of life impairment in generalized anxiety disorder, social phobia, and panic disorder. *Journal of Anxiety Disorders, 23*(9), 1086-1090. doi:10.1016/j.janxdis.2009.07.011.

Bilder, D. A., Pinborough-Zimmerman J., Miller J., & McMahon W. (2009). Prenatal, perinatal, and neonatal factors associated with autism spectrum disorders. *Pediatrics*, *123*(5), 1293-3000. doi: 10.1542/peds.2008-0927

Billstedt, E., Gillberg, C., & Gillberg, C. (2005). Autism after adolescence: Population-based 13- to 22-year follow-up study of 120 individuals with autism diagnosed in childhood. *Journal of Autism and Developmental Disorders*, *35*, 351–360.

Bitsika, V., & Sharpley, C. F. (2015). Variation in the profile of anxiety disorders in boys with an ASD according to method and source of assessment. *Journal of Autism and Developmental Disorders, 45,* 1825-1835. doi: 10.1007/s10803-014-2343-z

de Bruin, E. I., Ferdinand, R. F., Meester, S., de Nijs, P. F., & Verheij, F. (2007). High rates of psychiatric co-morbidity in PDD-NOS. *Journal of Autism and Developmental Disorders, 37,* 877-886. doi: 10.1007/s10803-006-0215-x

Buck, T. R., Viskochil, J., Farley, M., Coon, H., McMahon, W. M., Mogan, J., Bilder, & D. A. (2014). Psychiatric comorbidity and medication use in adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44*(12), 3063-3071. doi:10.1007/s10803-014-2170-2

Buescher, A.V., Cidav, Z., Knapp, M., & Mandell, D. S. (2014). Costs of autism spectrum disorders in the United Kingdom and the United States. *The Journal of the American Medical Association, 168*(8), 721-728. doi:10.1001/jamapediatrics.2014.210

Campbell, P. G., Malone, J., Yada, S., Chitale, R., Nasser, R.,… Ratliff, J.K. (2011). Comparison of ICD-9–based, retrospective, and prospective assessments of perioperative complications: Assessment of accuracy in reporting. *Journal of Neurosurgery: Spine, 14,* 16-22. doi: 10.3171/2010.9.SPINE10151

Cederlund, M., Hagberg, B., Billstedt, E., Gillberg, I. C., & Gillberg, C. (2008). Asperger

syndrome and autism: A comparative longitudinal follow-up study more than 5 years after original diagnosis. *Journal of Autism and Developmental Disorders*. *38*, 72–85. doi: 10.1007/s10803-007-0364-6

Centers for Disease Control. (2014). Prevalence of autism spectrum disorder among children ages 8 years – autism and developmental disabilities monitoring network, 11 sites, United States, 2010. *Morbidity and Mortality Weekly Report*, *63*(2), 1-21.

Cervantes, P. E., & Matson, J. L. (2015). Comorbid symptomatology in adults with autism spectrum disorder and intellectual disability. *Journal of Autism and Developmental Disorders, e-publication.* doi: 10.1007/s10803-015-2553-z

Charlot, L., Deutsch, C. K., Albert, A., Hunt, A., Connor, D. F., & Mcilvane, W. J. (2008). Mood and anxiety symptoms in psychiatric inpatients with autism spectrum disorder and depression. *Journal of Mental Health Research in Intellectual Disabilities, 1*(4), 238-253. doi:10.1080/19315860802313947

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.

Constantino, J. N., & Gruber, C. P. (2005). *Social Responsiveness Scale (SRS).* Los Angeles: Western Psychological Services.

Cottle, K. J., McMahon, W. M., & Farley, M. (2016). Adults with autism spectrum disorders: Past, present, and future. In S. Wright (Eds.), *The Challenge and promise of autism spectrum disorders in mid and later life* (pp. 34-56). London, UK: Jessica Kingsley Publishers.

Croen, L. A., Zerbo, O., Qian, Y., Massolo, M. L., Rich, S., Sidney, S., & Kripke, C. (2015). The health status of adults on the spectrum. *Autism, special issue,* 1-10. doi: 10.1177/1362361315577517

Denny, J. C. (2012). Chapter 13: Mining electronic health records in the genomics era. *PLoS Computational Biology, 8*(12), e1002823. doi:10.1371/journal.pcbi.1002823

Devine, M., Taggart, L., & McLornian, P. (2010). Screening for mental health problems in adults with learning disabilities using the Mini PAS-ADD. *British Journal of Learning Disabilities*, *38*, 252-258. doi: 10.1111/j.1468-3156.2009.00597.x

Dismuke, C. E. (2005). Underreporting of computed tomography and magnetic resonance imaging procedures in inpatient claims data. *Medical Care, 43*(7), 713-717.

Dubin, A. H., Lierberman-Betz, R., & Lease, A. M. (2015). Investigation of individual

factors associated with anxiety in youth with autism spectrum disorders. *Journal of Autism and Developmental Disorders, published online.* doi: 10.1007/s10803-015-2458-x

Eaves, L. C., & Ho, H. (2008). Young adult outcome of autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *38*, 739–747. doi.org/10.1007/s10803-007-0441-x

Elliott, C. (1990). *Differential Ability Scales*. San Antonio, TX: The Psychological Corporation.

Engstrom, I., Ekstrom, L., & Emilsson, B. (2003). Psychosocial functioning in a group of Swedish adults with Asperger syndrome or high-functioning autism. *Autism*, 7, 99–110.

Farley, M. A., McMahon, W. M., Fombonne, E., Jenson, W. R., Miller, J. Gardner, M.,…Coon, H. (2009). Twenty-year outcome for individuals with autism and average or near-average cognitive abilities. *Autism Research, 2*(2), 109-118. doi:10.1002/aur.69

Frazier, T. W., Georgiades, S., Bishop, S. L., & Hardan, A. Y. (2014). Behavioral and cognitive characteristics of females and males with autism in the simons simplex collection. *Journal of the American Academy of Child and Adolescent Psychiatry, 53*(3), 329-340. doi:10.1016/j.jaac.2013.12.004

Ghaziuddin, M. (2008). Anxiety disorders in autism and Asperger syndrome. In M. Ghaziuddin (Eds.), *Mental health aspects of autism and Asperger syndrome* (pp. 253-293). London, UK: Jessica Kingsley Publishers.

Gillberg, I. C., Helles, A., Bilstedt, E., & Gillberg, C. (2016). Boys with asperger syndrome grow up: Psychiatric and neurodevelopmental disorders 20 years after initial diagnosis. *Journal of Autism and Developmental Disorders, 46*(1), 74-82. doi: 10.1007/s10803-015-2544-0.

Gillott, A., & Standen, P. J. (2007). Levels of anxiety and sources of stress in adults with autism. *Journal of Intellectual Disabilities, 11*(4), 359-370. doi: 10.1177/1744629507083585

Gotham, K., Brunwasser, S. M., & Lord, C. (2015). Depressive and anxiety symptom trajectories from school age through young adulthood in samples with autism spectrum disorder and developmental delay. *Journal of the American Academy of Child & Adolescent Psychiatry, 54*(5), 369-376. doi:10.1177/1362361315583818

Hallett, V., Lecavelier, L., Sukhodolsky, D. G, & Cipriano, N. (2013). Exploring the manifestations of anxiety in children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 43*(10), 2341-2352. doi:10.1007/s10803-

013-1775-1

Helles, A., Gillberg, C. I., Gillberg, C., & Billstedt, E. (2015). Asperger syndrome in males over two decades: Stability and predictors of diagnosis. *Journal of Child Psychology and Psychiatry, 56*(6), 711-718. doi: 10.1111/jcpp.12334

Henninger, N., & Taylor, J. L. (2013). Outcomes in adults with autism spectrum disorders: A historical perspective. *Autism, 17*(1), 103-116. doi:1177/1362361312441266

Hofvander, B., Delorme, R., Chaste, P., Nyden, A., Wentz, E., Stahlberg, O.,… Leboyer, M. (2009). Psychiatric and psychosocial problems in adults with normal-intelligence autism spectrum disorders. *BMC Psychiatry, 9*(35), 1-9. doi:10.1186/1471-244X-9-35

Hogan, W. R., & Wagner, M. M. (1997). Accuracy of data in computer-based patient records. *Journal of the American Medical Informatics Association, 4*(5), 342-355.

Holden, B., & Gitlesen, J. P. (2004). The association between severity of intellectual disability and psychiatric symptomology. *Journal of Intellectual Disability Research, 48*, 556–562. doi: 10.1111/j.1365-2788.2004.00624.x

Hollocks, M. J., Howlin, P., Papadopoulos, A. S., Khondoker, M., & Simonoff, E. (2014). Differences in HPA-axis and heart rate responsiveness to psychosocial stress in children with autism spectrum disorders with and without co-morbid anxiety. *Psychoneuroendocrinology, 46*, 32-45. http://dx.doi.org/10.1016/j.psyneuen.2014.04.004

Howlin, P. (2000). Outcome in adult life for more able individuals with autism or Asperger syndrome. *Autism, 4*(1), 63-83.

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. *Journal of Child Psychology and Psychiatry*, 45, 212–229.

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder—a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *Journal of Child Psychology and Psychiatry*, *41*, 561–578.

Jones, K. B., Cottle, K. J., Bakian, A., Farley, M., Bilder, D., Coon, H., & McMahon, W. M. (2015). A description of medical conditions in adults with autism spectrum disorder: A follow-up of the 1980s Utah/UCLA autism epidemiologic study. *Autism, online*, 1-11. doi:10.1177/1362361315594708

Joshi, G., Wozniak, J., Petty, C., Martelon, M. K., Freid, R., Bolfek, A., Kotte, A., … Biederman, J. (2013). Psychiatric comorbidity and functioning in a clinically

referred population of adults with autism spectrum disorders: A comparative study. *Journal of Autism and Developmental Disorders, 43,* 1314-1325. doi: 10.1007/s10803-012-1679-5

Kaat, A. K., & Lucavelier, L. (2015). Reliability and validity of parent- and child-rated anxiety measures in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(32), 3219-3231. doi: 10.1007/s10803-015-2481-y

Kanne, S. M., Christ, S. E., & Reiersen, A. M. (2009). Psychiatric symptoms and psychosocial difficulties in young adults with autistic traits. *Journal of Autism and Developmental Disorders, 39*(6), 827–833. doi:10.1007/s10803-008-0688-x

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217-250.

Kaspersen, S. L., Pape, K., Vie, G. A., Ose, S. O., Krokstad, S., Gunnell, D., & Bjorngaard, J. H. (2016). Health and unemployment: 14 years of follow-up on job loss in the Norwegian HUNT study. *European Journal of Public Health, 26*(2), 312-317. doi: 10.1093/eurpub/ckv224

Kats, D., Payne, L., Parlier, M., & Piven, J. (2013). Prevalence of selected clinical problems in older adults with autism and intellectual disability. *Journal of Neurodevelopmental Disorders, 5*(27), 1-12. doi:10.1186/1866-1955-5-27

Kerns, C. M., & Kendall, P. C. (2013). The presentation and classification of anxiety in autism spectrum disorder. *Clinical Psychology Science and Practice, 19*, 323-347.

Kerns, C. M., Kendall, P. C., Berry, L., Souders, M. C., Franklin, M. E., Schultz, R. T., Miller, J., & Herrington, J. (2014). Traditional and atypical presentations of anxiety in youth with autism spectrum disorder. *Journal of Autism and Developmental Disabilities, 44,* 2851-2861. doi: 10.1007/s10803-014-2141-7

Kerns, C. M., Kendall, P. C., Zickgraf, H., Franklin, M. E., Miller, J., & Herrington, J. (2015). Not to be overshadowed or overlooked: Functional impairments associated with comorbid anxiety disorders in youth with ASD. *Behavior Therapy, 46,* 29-39. doi:10.1016/j.beth.2014.03.005

Kerns, C. M., Renno, P., Kendall, P. C., Wood, J. J., & Storch, E. A. (2016). Anxiety disorders interview schedule-autism addendum: Reliability and validity in children with autism spectrum disorder. *Journal of Clinical Child and Adolescent Psychology, 46*(1), 88-100. http://dx.doi.org/10.1080/15374416.2016.1233501

Kessler, R. C., Berglund, P., Demier, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Archives for General Psychiatry, 62*(6), 593-602. doi:10.1001/archpsyc.62.6.593

Kessler, R. C., Chiu, W. T., Demier, O., Merikangas, K. R., & Walters, E. E. (2005). Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the national comorbidity survey replication. *Archives of General Psychiatry, 62*(6), 617-627. doi: 10.1001/archpsyc.62.6.617

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, & H. U. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research, 21*(3), 169-184. doi: 10.1002/mpr.1359

Kohane, I. S., McMurry, A., Weber, G., MacFadden, D., Rappaport, L., Kunkel, L., …Churchill, S. (2011). The co-morbidity burden of children and young adults with autism spectrum disorders. *PLoS ONE, 7*(4), e33224. doi:10.1371/journal.pone.0033224.t002

Kreslins, A., Robertson, A. E., & Melville, C (2015). The effectiveness of psychosocial interventions for anxiety in children and adolescents with autism spectrum disorder: A systematic review and meta-analysis. *Child and Adolescent Psychiatry and Mental Health, 9*(22), 1-12. doi: 10.1186/s13034-015-0054-7

Lanni, K. E., Schupp, C. W, Simon, D., & Corbett, B. A. (2012). Verbal ability, social stress, and anxiety in children with Autistic Disorder. *Autism, 16*(2), 123-138. doi:10.1177/1362361311425916

Lever, A. G., & Geurts, H. M. (2016). Psychiatric co-occurring symptoms and disorders in young, middle-aged, and older adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 46*(6), 1916-1930. doi:10.1007/s10803-016-2722-8

Leyfer, O. T., Folstein, S. E., Bacalman, S., Davis, N. O., Dinh, E., Morgan, J., … Lainhart, J. E. (2006). Comorbid psychiatric disorders in children with autism: Interview development and rates of disorders. *Journal of Autism and Developmental Disorders, 36,* 849-861. doi: 10.1007/s10803-006-0123-0

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., DiLavore, P. C., & Rutter, M. (2000). The Autism Diagnostic Observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*(3), 205–223.

Lord, C., Rutter, M., & LeCouteur, A. (1994). Autism Diagnostic Interview—Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*(5)*,* 659–685.

Lugnegard, T., Hallerback, M. U., & Gillberg, C. (2011). Psychiatric comorbidity in

young adults with a clinical diagnosis of Asperger syndrome. *Research in Developmental Disabilities, 32,* 1910-1917. doi:10.1016/j.ridd.2011.03.025

Maddox, B. B., & White, S. W. (2015). Comorbid social anxiety disorder in adults with autism spectrum disorder. *Journal of Autism and Developmental Disabilities, published online.* doi: 10.1007/s10803-015-2531-5

Magiati, I., Tay, X. W., & Howlin, P. (2014). Cognitive, language, social and behavioural outcomes in adults with autism spectrum disorders: A systematic review of longitudinal follow-up studies in adulthood. *Clinical Psychology Review*, *34,* 73-86. http://dx.doi.org/10.1016/j.cpr.2013.11.002

Mawhood, L., Howlin, P., & Rutter, M. (2000). Autism and developmental receptive language disorder—a comparative follow-up in early adult life. I: Cognitive and language outcomes. *Journal of Child Psychology & Psychiatry*, *41*, 547–559.

Mazefsky, C. A., Folstein, S. E., & Lainhart, J. E. (2008). Overrepresentation of mood and anxiety disorders in adults with autism and their first degree relatives: What does it mean. *Autism Research, 1*(3), 193-197. doi:10.1002/aur.23.

Medicode (Firm). (1996). *ICD-9-CM: International Classification of Diseases, Ninth Revision, Clinical Modification*. Salt Lake City, Utah: Medicode

Miller, J. S., Bilder, D., Farley, M., Coon, H., Pinborough-Zimmerman, J., Jenson, W., … McMahon, W. M. (2013). Autism spectrum disorder reclassified: A second look at the 1980s Utah/UCLA autism epidemiologic study. *Journal of Autism and Developmental Disabilities, 43*(1), 200-210. doi: 10.1007/s10803-012-1566-0

Mojtabai, R., Stuart, E. A., Hwang, I., Eaton, W. W., Sampson, N., & Kessler, R. C. (2015) Long-term effects of mental disorders in educational attainment in the national comorbidity survey ten-year follow-up. *Social Psychiatry and Psychiatric Epidemiology, 50*(10), 1577-1591. doi:10.1007/s00127-015-1083-5.

Mojtabai, R., Stuart, E. A., Hwang, I., Susukida, R., Eaton, W. W., Sampson, N., & Kessler, R. C. (2015). Long-term effects of mental disorders on employment in the national comorbidity survey ten-year follow-up. *Social Psychiatry and Psychiatric Epidemiology, 50*(11), 1657-1668. doi:10.1007/ s00127-015-1097-z.

Moss, S., Prosser, H., Costello, H., Simpson, N., Patel, P., Rowe, S., Turner, S., & Hatton, C. (1998). Reliability and validity of the PAS-ADD Checklist for detecting psychiatric disorders in adults with intellectual disability. *Journal of Intellectual Disability Research, 42*(2), 173-183. doi: 10.1046/j.1365-2788.1998.00116.x

Muhle, R., Trentacoste, S. V., & Rapin, I. (2004). The genetics of autism. *Pediatrics*,

113(5).

Mullen, E. M. (1995). *Mullen Scales of Early Learning* (AGS ed.). Circle Pines, MN: American Guidance Service Inc.

Murphy, S., Churchill, S., Bry, L., Chueh, H., Weiss, S., Lazarus, R., Zeng, Q., … Kohane, I. (2009). Instrumenting the health care enterprise for discovery research in the genomic era. *Genome Research, 19*(9), 1675-1681. doi: 10.1101/gr.094615.109

Orsmond, G.I., Shattuck, P.T., Cooper, B.P., Sterzing, P.R., & Anderson, K.A. (2013). Social participation among young adults with an autism spectrum disorder. *Journal of Autism and Developmental Disorders, 43*(11), 2710-2719. doi:10.1007/s10803-013-1833-8

Ozsivadjian, A., Hibberd, C., & Hollocks, M. J. (2014). Brief report: The use of self-report measures in young people with autism spectrum disorder to access symptoms of anxiety, depression and negative thoughts. *Journal of Autism and Developmental Disorders, 44,* 969-974. doi:10.1007/s10803-013-1937-1

Ozsivadjian, A., Knott, F., & Magiati, I. (2012). Parent and child perspectives on the nature of anxiety in children and young people with autism spectrum disorders: A focus group study. *Autism, 16*(2), 107-121. doi: 10.1177/1362361311431703

Prosser, H., Moss, S., Costello, H., Simpson, N., Patel, P., & Rowe, S. (1998). Reliability and validity of the Mini PAS-ADD for assessing psychiatric disorders in adults with intellectual disability. *Journal of Intellectual Disability Research, 41*(4), 264-272.

Renno, P., & Wook, J. J. (2013). Discriminant and convergent validity of the anxiety construct in children with autism spectrum disorders. *Journal of Autism And Developmental Disabilities, 43*(9), 2135-2146. doi:10.1007/s10803-013-1767-1

Ritvo, E. R., Freeman, B. J., Pingree, C., Mason-Brothers, A., Jorde, L., Jenson, W. R., McMahon, W. M., … Rivo, A. (1989). The UCLA—University of Utah Epidemiological Survey of Autism: Prevalence. *American Journal of Psychiatry, 146*(2), 194-199. doi:10.1176/ajp.146.2.194

Rodgers, J., Glod, M., Connolly, B., & McConachie, H. (2012). The relationship between anxiety and repetitive behaviours in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*(24), 2404-2409. doi: 10.1007/s10803-012-1531-y

Rogers, S. J., & Vismara, L. A. (2008). Evidence-based comprehensive treatments for early autism. *Journal of Clinical Child and Adolescent Psychology, 37*(1), 8-28. doi: 10.1080/15374410701817808

Roid, G. H. (2003). Stanford-Binet Intelligence Scales (5th ed.). Rolling Meadows, IL: Riverside Publishing.

Roid, G., & Miller, L. (1997). *Leiter international performance scale-revised*. Wood Dale, IL: Stoelting.

Roux, A. M., Shattuck, P. T., Cooper, B. P., Anderson, K. A., Wagner, M., & Narendorf, S. C. (2013). Postsecondary employment experiences among young adults with an autism spectrum disorder: Employment in young adults with autism. *Journal of American Academy of Child and Adolescent Psychiatry, 52*(9), 931-939. doi:10.1016/j.jaac.2013.05.019

Roux, A. M., Shattuck, P. T., Rast, J. E., Rava, J. A., & Anderson, K. A. (2015). *National autism indicators report: Transition into young adulthood.* Philadelphia, PA: Life Course Outcomes Research Program, A.J. Drexel Autism Institute, Drexel University.

Roy, M., Prox-Vagedes, V., Ohlmeier, M. D., & Dillo, W. (2015). Beyond childhood: Psychiatric comorbidities and social background of adults with aspsperger syndrome. *Psychiatria Danubina, 27*(1), 50-59.

Rubenstein, E., Wiggins, L. D., & Lee, L. C. (2015). A review of the differences in developmental, psychiatric, and medical endophenotypes between males and females with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 27*(1), 119-139. doi:10.1007/s10882-014-9397-x

Rumsey, J. M., Rapoport, J. L., & Sceery, W. R. (1985). Autistic children as adults: Psychiatric, social, and behavioral outcomes. *Journal of the American Academy of Child Psychiatry, 24*(4), 465-473.

Rutter, M., Bailey, A., & Lord, C. (2003). *The social communication questionnaire*. Los Angeles: Western Psychological Services.

Sharpley, C. F., Bitsika, V., Agnew, L. L., & Andronics, N. M. (2015). Eight-month test–retest agreement in morning salivary cortisol, self- and parent-rated anxiety in boys with an Autism Spectrum Disorder. *Physiology and Behavior, 151,* 207-212. http://dx.doi.org/10.1016/j.physbeh.2015.07.027

Sigman, M., & McGovern, C. W. (2005). Improvement in cognitive and language skills from preschool to adolescence in autism. *Journal of Autism and Developmental Disabilities, 35*(1), 15-23. doi: 10.1007/s10803-004-1027-5

Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *Survey form manual for the interview edition of the Vineland Adaptive Behavior Scales*. Circle Pines, MN: American Guidance Service.

Sterling, L., Renno, P., Storch, E. A., Ehrenreich-May, J., Lewin, A. B., Arnold, E., Lin, E., & Wood, J. (2015). Validity of the revised children's anxiety and depression scale for youth with autism spectrum disorders. *Autism, 19*(1), 113-117. doi: 10.1177/1362361313510066

Swain, D., Scarpa, A., White, S., & Laugeson, E. (2015). Emotion dysregulation and anxiety in adults with ASD: Does social motivation play a role. *Journal of Autism and Developmental Disabilities, published online.* doi: 10.1007/s10803-015-2567-6.

Szatmari, P., Bartolucci, G., & Bremner, R. (1989). Asperger's syndrome and autism: Comparison of early history and outcome. *Developmental Medicine and Child Neurology, 31*(6), 709–720.

Tantam, D. (1991). Asperger syndrome in adulthood. In U. Frith (Ed.), *Autism and Asperger syndrome* (pp. 147–183). Cambridge, UK: Cambridge University Press.

Taylor, J. L., Dove, D., VeenstraVanderWeele, J., Sathe, N., McPheeters, M. L., Jerome, R. N., & Warren, Z. (2012). *Interventions for adolescents and young adults with autism spectrum disorders* (Report No. 12-EHC063-EF). Retrieved from Vanderbilt Evidence-based Practice Center. http://www.ncbi.nlm.nih.gov/books/NBK107275/

Taylor, J. L., & Mailick, M. R. (2014) A longitudinal examination of 10-year change in vocational and educational activities for adults with autism spectrum disorders. *Developmental Psychology, 50*(3), 699–708. doi: 10.1037/a0034297

Thiru, K., Hassey, A., & Sullivan, F. (2003). Systematic review of scope and quality of electronic patient record data in primary care. *British Medical Journal, 326*(7398), 1-5. doi:10.1136/bmj.326.7398.1070

Ung, D., Selles, R., Small, B. J., & Storch, E. A. (2014). A systematic review and meta-analysis of cognitive-behavioral therapy for anxiety in youth with high-functioning autism spectrum disorders. *Child Psychiatry and Human Development, epub.* doi: 10.1007/s10578-014-0494-y

Vannucchi, G., Masi, G., Toni, C., Dell'Osso, L., Marazziti, D., & Perugi, G. (2014). Clinical features, developmental course, and psychiatric comorbidity of adult autism spectrum disorders. *CNS Spectrums, 2014, 19*(2), 157-164. doi: 10.1017/S1092852913000941

Vogeley, K., Kirchner, J. C., Gawronski, A., van Elst, T. L., & Dziobk, I. (2013). Toward the development of a supported employment program for individuals with high-functioning autism in Germany. *European Archives of Psychiatry and Clinical Neuroscience, 263*(2), 197-203. doi:10.1007/s00406-013-0455-7

Vohra, R., Madhavan, S., & Sambamoorthi, U. (2016). Comorbidity prevalence, healthcare utilization, and expenditures of medicaid enrolled adults with autism specturm disorders. *Autism,* published online. doi: 10.1177/1362361316665222

Wang, M. C., Laud, P. W., Macia, M., & Nattinger, A. B. (2010). Strengths and limitations of international classification of disease ninth revision clinical modification codes in defining cervical spine surgery. *Spine, 36*(1), E38-E44. doi:10.1097/BRS.0b013e3181d273f6

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children–Revised.* New York: The Psychological Corporation.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale–Revised.* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1991). *Wechsler Intelligence Scale for Children* (3rd ed.). San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1992). *Wechsler Individual Achievement Test.* San Antonio, TX: The Psychological Corporation.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale* (4th ed.). San Antonio, TX: The Psychological Corporation.

Wei, Z., Wagner, M., Hudson, L. Yu, J.W., & Shattuck, P. (2015). Transition to adulthood: Employment, education, and disengagement, in individuals with autism spectrum disorder. *Emerging Adulthood, 3*(1), 37-45. doi: 10.1177/2167696814534417

Wigham, S., & McConachie, H. (2014). Systematic review of the properties of tools used to measure outcomes in anxiety intervention studies for children with autism spectrum disorders. *PLoS ONE 9*(1), e85268. doi:10.1371/journal.pone.0085268

Wing, L. (1981). Asperger's syndrome: A clinical account. *Psychological Medicine, 11*, 115–129. doi:10.1017/S0033291700053332

White, S. W., & Roberson-Nay, R. (2009). Anxiety, social deficits, and loneliness in youth with autism spectrum disorders. *Journal of Autism and Developmental Disabilities, 39,* 1006-1013. doi: 10.1007/s10803-009-0713-8

Wood J. J., Ehrenreich-May, J., Alessandra, M., Fujii, C., Renno, P., Laugeson, E.,… Storch, E. A. (2015). Cognitive behavioral therapy for early adolescents with autism spectrum disorders and clinical anxiety: A randomized, control trial. *Behavior Therapy, 46*(1), 7-19. doi: 10.1016/j.beth.2014.01.002

Wright, S. D., Brooks, D. E., D'Astous, V. D., & Grandin, T. (2013). The challenge and

promise of Autism Spectrum Disorders in adulthood and aging: A systematic review of the literature (1990-2013). *Autism Insights, 5*, 21-73. doi:10.4137/AUI.S11072

Zivin, K., Yosef, M., Levine, D. S., Abraham, K. M., Miller, E. M., Henry, J., Nelson, C. B., … Valenstein, M. (2016). Employment status, employment functioning, and barriers to employment among VA primary care patients. *Journal of Affective Disorders, 193,* 194-202. doi: 10.1016/j.jad.2015.12.054